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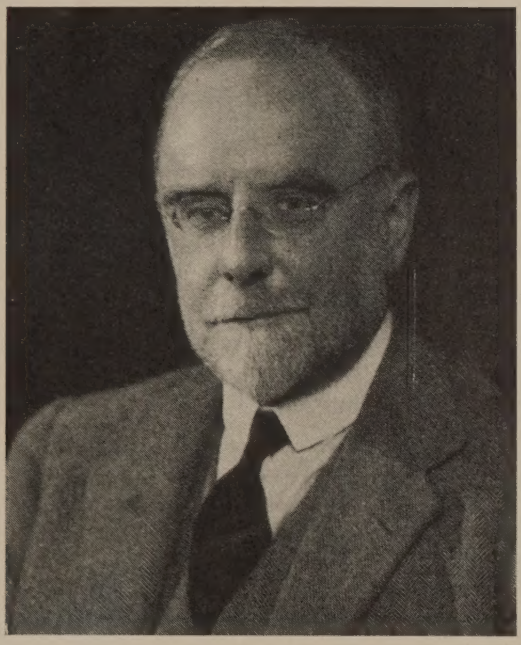


E. S. Russell.

1887—1954.

EDWARD STUART RUSSELL was born near Glasgow on 25. March 1887. He died in Sussex on 24. August 1954 — that is, at the early age of 67. To those who knew him well, this could not come as a great surprise, because his health was never good, and the key to his life's work lay in this, that by force of intellect and character, he was effective and permanently constructive within the strict limits set by a weak heart.

Like many another son of a Scottish "manse", he made a reputation as one of the freest of thinkers, but in my opinion,

his independence of contemporary fashions in thought, and his invincible serenity, could reasonably be identified as belonging to his upbringing. Nor did he ever fail to recognize the domain of the spiritual.

At Glasgow University, he was a student of Professor, now Sir John, Graham Kerr, and he told me later how much he owed to that robust example. After graduating, he worked with Professor J. Arthur Thompson at Aberdeen, where he became a friend of the late Patrick Geddes. He also worked then on collections from the fishery research vessel "Goldseeker" — his first contact with what was to be his life's work. Russell was, incurably, a sound zoologist, whose successful development into, on the one hand, a master of fishery research, and on the other, an Aristotelian philosopher, never reduced his liking for his early work on Coelenterates, on *Patella,* and on Cephalopods, nor for any other zoological interest that came his way in later life. He was, in addition, intensely fond of animals and understanding of them.

At the age of 22, he joined the late A. T. Masterman in the Fisheries Department, where a scheme was afoot to take over fishery research from the Marine Biological Association. This did not prevent Russell from being a good friend of J. O. Borley and others on the M. B. A. staff, though he was more than a little embarrassed when in 1921 he was appointed their director in the Department. He was young for this appointment, and it was made against his own pleading, but it was outstandingly successful. He combined an intellect superior to those of most of his contemporaries with a gentle humanity that allowed him to rely entirely on the good qualities of any man on his staff, without the work being in any way hampered by his undoubted awareness of the faults. At a stage when fishery research needed time to discover its own usefulness, Russell's patient and kindly guidance was almost ideal. All that a man on his staff needed was the knowledge that the Director would drop in every few weeks, and in a very few minutes understand fully what progress had been made, and immediately illuminate the next ground to be trodden. He rarely suggested that one was under any obligation to take his advice, but one usually did. His own strong line was a business-like appreciation of statistical data. He was accurate, discerning, and of sound judgement in this field, which plays so large a part in fishery science. His introduction of statistical rectangles instead of depth areas forms an enduring testimonial to his shrewdness here. His claims to statistical expertise were modest indeed; but it is truly surprising how much of the data,

collected under his direction without an adequate theory of fish population dynamics, proved to be what was required when such a theory became available.

As is well known, it was his own paper of 1931 that ushered in the new period, when an adequate theory was gradually developed. It was characteristic that nobody was more surprised than he was, when his paper was found to be so important. He had, when he wrote it, regarded it as an intellectual exercise and the modesty with which it was written was a true reflection of his mood at the time. He was then, with F. M. Davis's able help, launching the regulation by mesh, on which the countries of the International Council are now so busily engaged, and which has been adopted too on the other side of the Atlantic Ocean. Russell had the warmest affection for the International Council, and his manifest enjoyment of it had, I think, a great deal to do with his success there. He was the first Editor of this journal, to whom it owes much. He was also Chairman of the Consultative Committee from 1938 to 1946, but the influence of his helpful activities extended over the whole field of the Council.

Successful as Russell was in his 36 years in office, he deeply disliked officialdom and all its works. No institutions could seem less official than the Fisheries Laboratories as he made them, and he only achieved this free and personal atmosphere by obstinate and skilful defence at high level. Not that he was in any way disloyal or indifferent to the problems of government — indeed, during the first World War he was a very successful Inspector of Fisheries; but he was determined that the trivialities of official life should not, as they could, shake the independent and often irregular attitude of people whose business is to make new discoveries. An illuminating illustration of his mastery of the situation is afforded by his minutes on official papers. Never, surely, were shorter minutes; and even the handwriting was economical. But they were usually effective. The same is true of his verbal contributions at committee meetings; for most of the time he was disconcertingly silent, a silence broken at last by a sentence such as, "I'm afraid I must insist" — that and no more, followed by more silence while the committee made the best of it. It is not surprising that he nearly always had his way. As a Scot with a career, he had to have his way, and is was fortunate for the rest of us that his personal ambition was wisely limited to what was well within his powers. His pleading against early appointment as Director was part of a general abstention. He sought neither honours nor reputation, although he was human enough

to be pleased to be President of Section D (Zoology) of the British Association in 1934, and President of the Linnean Society in 1940—42. He had no wish to dominate, but only to achieve enough power to enable him to give some naturalists and some fishermen sufficient elbow-room to live satisfactory lives. His fundamental motive in fishery research was personal liking for those two classes of men, naturalists and fishermen.

Progress in fishery science was slow, and Russell accepted that, in that phase. It had to wait for basic information that was lacking, except for plaice. His official work could not provide sufficient occupation for an active brain, and Russell was influenced partly by Patrick Geddes to turn to the then fashionable biological philosophies and to find them inadequate. That led to a tremendous course of reading of the philosophy of the organic world, from the time of Aristotle to the present, and to a great book, *Form and Function*. This can be regarded as the parent of his later books, of which he wrote several. All are written with admirable simplicity and clarity, all contain sound precepts, but they are, as it were, corollaries of the main, essentially Geddesian, conclusion of *Form and Function*, that no appreciation of animals has been satisfactory that has rested content with analysis into parts, whether anatomical, physiological, or Pavlovian. The meaningful entity is the "frog", not its webbed feet, nor its reflex jumping, and studies will be fruitful when they end by considering the whole frog; and Russell, ever economical of effort, would add that often they might as well begin there.

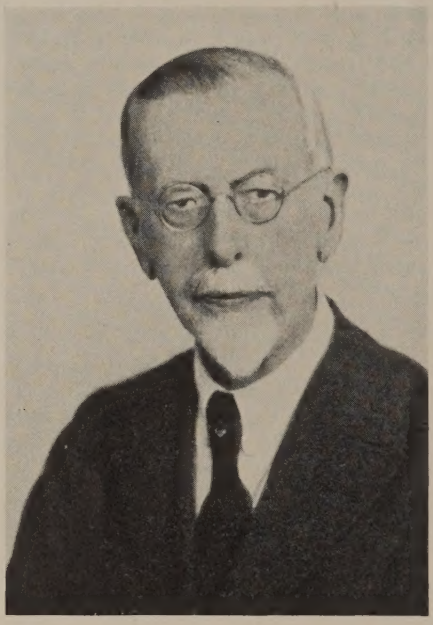
The method of exposition in the books makes them of permanent value, irrespective of their conclusions. His arguments were developed with the aid of significant examples, in which he spared no pains to lay bare the full meaning. They have, consequently, a unique educational value, refreshingly unlike the inevitable generalizations of the textbooks. They have also the stimulating effect of heterodoxy. Russell was a convinced Lamarckian and he suggested that Samuel Butler was on sound lines in bringing hereditary memory in, as an essential means of preserving adaptation through the generations.

As for the main issue that Russell joined, the truth may be judged by the fruits of Russell's attitude. Surely the school of Lorenz, Tinbergen, and Baerends has revealed more of the essence of an animal than have those of Mendel, or of Pavlov, or of Experimental Biology — which is not to say that the fragmentary truths of these last studies are to be neglected. The relative profit stands out when

one reflects on the relative efforts of the schools, measured, for example, by volume of publications.

Alert for the new, ever sifting the truth from the old; mindful that human understanding is limited; fond of his fellow-men: it was not a bad prescription for a life to leave a mark.

Michael Graham.



Vagn Walfrid Ekman.

1874—1954.

PROFESSOR Vagn Walfrid Ekman died at the age of 79 on 9. March 1954. Though his name and achievements are well known to everybody engaged in the exploration of the sea, the oceanographers of the present generation have rarely seen him at the meetings of the International Council, as nearly half a century has gone by since he was in the Council's service. He was on the staff of the Central Laboratory in Oslo (then Christiania) from the start of the laboratory, in 1902, until 1909. On occasions he was invited to the meetings of the International Council, and at the meeting in Copenhagen in 1931 he gave a lecture on internal waves, but he never attended the Council meetings in the capacity of a delegate or expert.

He was born on 3. May 1874, the youngest son of Professor Fredrik Laurentz Ekman, who was a pioneer of physical oceanography in Sweden. He was educated at a secondary school in Stockholm and graduated at Uppsala. When preparing for the rigorous private examinations, he used to spend a few weeks in his home in the Skärgård. In late autumn the small passenger boats were laid up for the winter, so that it came to pass that the future explorer of the dynamics of ocean currents had to row a dozen miles in the night in order to appear before the examiners. When Vilhelm Bjerknes delivered his famous lectures on hydrodynamics in Stockholm in 1897, Ekman was among his audience. This definitely decided the bent of his future research. One day Fridtjof Nansen asked Bjerknes to let one of his students make a theoretical study of the influence of the earth's rotation on wind-produced currents, on the basis of Nansen's observations of the ice-drift during the polar expedition in the "Fram". Ekman was at once chosen and later presented a solution of the problem in his thesis, a small paper on wind-driven currents. He took his degree in Uppsala in 1902. After the sojourn in Oslo, he returned to Sweden and became professor of mechanics and mathematical physics at the University of Lund, where he remained until 1939.

During the years in the Central Laboratory in Oslo the distinguished theoretician proved to be a skilled experimentalist as well. Ekman's current-meter is an instrument of rare perfection, and until a few years ago most gravity-corers in general use were modifications of the one devised by his father and perfected by him. The Ekman reversing water-bottle is another instance of his inventive genius. In his paper, "On dead-water: being a description of the so-called phenomenon often hindering the headway of ships in Norwegian fjords and elsewhere, and an experimental investigation of its causes", he explained a phenomenon that had often been regarded previously as a mere figment of the imagination. His main interest remained, however, with the dynamics of ocean currents, and his contributions to this branch of science have secured him a position among the founders of modern oceanography. In an early paper on the salt bottom-current which travels upstream in rivers as they enter the sea, a phenomenon discovered by his father, he anticipated the notion of eddy viscosity. His theory of the development and the vertical distribution of currents caused by wind and gravity was naturally based on simplifying postulates. His lifelong efforts to perfect the theory made it necessary to investigate the intricate problem of turbulence, to

the unravelling of which Ekman devoted himself to a large extent.

In the years 1922—1929 Ekman and Helland-Hansen improved the technique of current measurement from anchored ships and made several excursions for that purpose off the Norwegian coast on board the "Armauer Hansen". After thorough preparation, they undertook in the summer of 1930 a cruise to the North Atlantic trade-wind region in order to measure, in the first place, the *average* current at various levels at a number of stations. However, analysis of the data also gave information about periodic or irregular *variations* of the motion. Preliminary reports were given by Ekman and Helland-Hansen soon after the cruise, but the final report was published by Ekman in 1953, when he had reached the age of 79. The long delay was to a certain extent due to the unparalleled care which Ekman took in his work, but was chiefly attributable to the loss of certain documents during the occupation of Norway. When he had completed this report in his old age — and the paper, "Studies on ocean currents", bears witness that he did so with unimpaired mental energy — he felt with deep satisfaction that he had completed the aim of his life, which is indeed a prize not often granted to a mortal. Nevertheless, in the autumn of 1953 he commenced an investigation on turbidity currents, and a few days before his death one of his friends received a letter from him on this topic.

Though he was a Swede, it was Norway that furnished him with the opportunities for scientific research. Nansen and Bjerknes were his teachers and friends, and many were the summer vacations he spent in Bergen with Helland-Hansen, his lifelong friend and collaborator.

It is difficult for one who is his junior by a generation to outline the personality of Walfrid Ekman. His way of looking at things was determined by a sincere religiousness. He was naturally a very reticent man but his genuine kindliness of mind prevented this trait from becoming a cold reserve. Certainly he never spoke or acted unkindly in all his life. His sense of right was uncompromising and under no pretext would he allow injustice to be done to anybody. His exactness was extraordinary and gave rich fruits in his scientific work, though it appears that it was somewhat of a handicap to him as a university lecturer. He loved music and spent much time at the piano, playing Bach, Chopin, or — above all — Beethoven. With his beautiful bass voice, he had also much pleasure from singing. He was a composer and a day or two before his death

he completed the music to a Swedish poem which he particularly loved.

His was a rich and happy life, shared by his wife, and cousin, Ingeborg Ekman until her death in 1939. He is survived by four daughters.

B. Kullenberg.

The Chemistry of the Irish Sea. Part I. The Sulphate-Chlorinity Ratio.

By

J. M. Bather and **J. P. Riley.**

Thompson, Lang, and Anderson (1) have reviewed the literature on the sulphate-chlorinity ratio of sea water up to 1926 and found, for 551 samples, an average of 0·13947 after correction for the variation in gravimetric factors, due to changes in the accepted atomic weights of barium, chlorine, and sulphur. For 90 samples from the North Pacific coast they found an average value of 0·1396 with a standard deviation of 0·0002. They also observed that sea water much diluted with river water had a lower ratio than ocean water. Thompson, Johnson, and Wirth (2) found a value of 0·1395 ± 0·0003 for the sulphate-chlorinity ratio of 40 samples taken from the Atlantic, Pacific, and Indian Oceans, and from the Mediterranean and Red Seas. Samples from the Baltic Sea gave a much higher ratio and standard deviation (0·1414 ± 0·0006). The variation in the ratio caused by the freezing of sea water has been investigated by Lewis and Thompson (3), who found that proportionately more sulphate than chloride was retained by the ice.

The present work has been carried out to investigate the variations in the sulphate-chlorinity ratio of the partially land-locked Irish Sea caused by dilution with river water. Thorpe and Morton (4) record two determinations of the sulphate and chloride concentrations of the Irish Sea, which give, when evaluated with modern atomic weights, a mean sulphate-chlorinity ratio of 0·13967.

The Determination of Sulphate in Sea Water.

Although several gravimetric (5, 6, 7, 8), volumetric (9, 10, 11, 12), polarographic (13), and nephelometric methods (14, 15) have been suggested for the determination of sulphate, few are as accurate as the classical gravimetric method of precipitation as barium sulphate. The latter method needs careful control when applied to sea water since

sodium and potassium are co-precipitated with barium sulphate (16); their interference can be reduced by carrying out the precipitation in the presence of picric acid (17, 18). A more serious error is caused by the co-precipitation of calcium as calcium sulphate, which causes low results; this error can be much reduced by carrying out the precipitation in the presence of a suitable concentration of hydrochloric acid. If too high a concentration of the latter is present, results are low owing to the increased solubility of barium sulphate in the acid. The interference of cations can also be eliminated by removing them by means of a cation exchange resin prior to the determination of sulphate (19, 20); this method, however, did not prove satisfactory with sea water.

To determine the optimum acidity for the determination of sulphate in sea water, a sulphate-free artificial sea water having the composition shown below was prepared; 50 ml. portions were diluted to 400 ml. and treated with 0·3550 g. of magnesium sulphate heptahydrate (brought to theoretical water content in a hygrostat; H_2O (found) 51·10 %, H_2O (theoretical) 51·11 %; SO_4 (found) 38·97 %, SO_4 (theoretical) 38·98 %). Varied amounts of 10 N hydrochloric acid were added and the sulphate determined as barium sulphate, as described in the experimental section.

Recovery of sulphate from artificial sea water:

Ml. of 10 N hydrochloric acid	1·0	2·5	5·0	7·5	10·0
Recovery, %	99·04	99·47	99·98	99·55	99·09

The results, which are shown below, are each the mean of three determinations, they indicate that 100 % recoveries of sulphate can be obtained from sea water if 5 ml. of 10 N hydrochloric acid are added before determination. This is rather less than was used by Thompson *et al.* (2), and perhaps explains why their SO_4/Cl ratio is less than that found in the present work.

Composition of Sulphate-Free Sea Water.

	g : L_{20}
Sodium chloride	25·58
Calcium chloride hexahydrate	2·21
Magnesium chloride hexahydrate	7·76
Potassium chloride	0·68
Strontium chloride hexahydrate	0·06

Barium sulphate precipitated from artificial sea water in the presence of 5 ml. of 10 N hydrochloric acid was found spectrographically to contain only negligible amounts of calcium and strontium.

To assess the accuracy of the proposed method, three artificial sea waters were made up having the compositions shown in Table 1. Portions of 50—60 ml. were weighed out by means of a weight burette and sulphate determined as described in the experimental section. The results, which are shown in Table 2, indicate that within experimental error, the recovery of sulphate is complete. Blank tests on an artificial sea water of similar composition to I, but not containing magnesium sulphate, showed that it did not contain weighable amounts of sulphate.

Table 1.

Compositions of Artificial Sea Waters (in g./L_{20}).

	I	II	III
Magnesium sulphate	7·119[1])	7·1122[1])	3·4771[2])
Magnesium chloride hexahydrate	7·760	7·761	7·720
Calcium chloride hexahydrate	2·363	2·361	2·356
Strontium chloride hexahydrate	0·062	0·063	0·062
Sodium chloride	25·583	25·584	25·741
Potassium chloride	0·679	0·680	0·682
Potassium bromide	0·100	0·100	—
Boric acid	0·026	0·025	—
Density (d_{20}^{20})	1·02665	1·02638	1·02620

[1]) as $MgSO_4\ 7H_2O$ [2]) as $MgSO_4$

Consideration was also given to the effect of the natural variation of the sulphur isotope abundances on the $SO_4 : BaSO_4$ ratio (21, 22). With the $^{34}S : ^{33}S : ^{32}S$ ratios reported by T r a f i m o v (22) for sea-water sulphate and terrestrial sulphur (4·60 : 0·81 : 100 and 4·57 : 0·80 : 100 respectively) it was shown that the error from this cause is infinitesimal (1 in 10^6).

Table 2.

Percentage Recovery of Sulphate from Artificial Sea Waters.

I		II		III	
Wt. of water g.	% recovered	Wt. of water g.	% recovered	Wt. of water g.	% recovered
60·438	100·03	51·178	99·97	60·529	100·00
54·890	100·03	51·177	99·97	53·614	99·99
55·924	99·99	51·180	99·97	53·520	99·99
56·664	100·15	51·183	99·97	52·915	99·99
51·204	99·94	51·191	99·97	54·920	99·98
51·173	99·99	51·169	99·97	—	—
51·204	100·06	51·202	100·00	—	—
51·198	99·94	51·216	99·97	—	—
51·140	99·96	51·171	99·91	—	—
—	—	51·190	99·97	—	—
Mean	99·99		99·97		99·99

The Sulphate-Chlorinity Ratio in the Irish Sea.

The sulphate-chlorinity ratio in the Irish Sea has been studied over the period February—July 1952, by means of surface samples collected for routine determination of chlorinity three times per week at each of nine stations (23) (Stations 1—9 in Figure 1). Equal portions (50 ml.) of the three samples from each station were carefully mixed, the chlorinity determined by potentiometric titration, and the sulphate content estimated as described in the experimental section. Similar determinations have been carried out on samples collected during spring 1952 at various depths at 16 other stations (Stations 10—25 in Figure

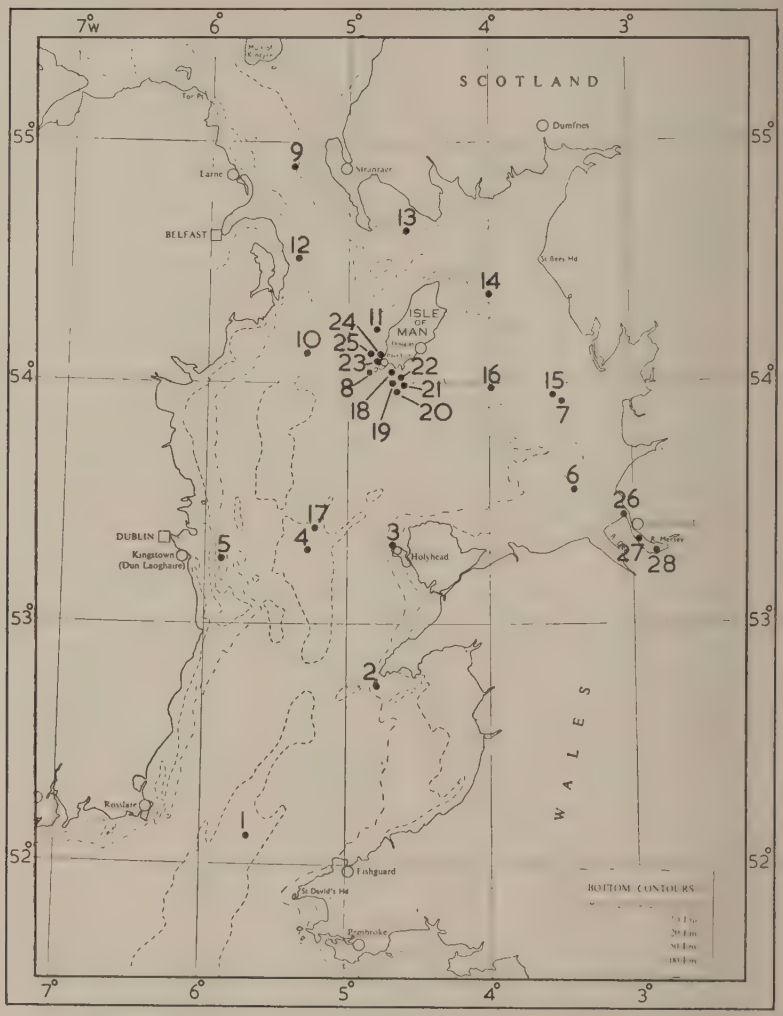


Figure 1. Chart of the Irish Sea showing position of stations.

1). The results, which are summarized in Table 3[1]), indicate that there is no significant variation, either between any of the stations, or with depth. The weighted mean value (0·13991 ± 0·00019) is in good agreement with that found by Thompson *et al.* (1, 2) for 130

[1]) The detailed results have been deposited with ICES's office in Copenhagen.

Table 3.

Sulphate-Chlorinity Ratios (average) for Irish Sea.

Station	Lat. N.	Long. W.	Number of determinations	Mean chlorinity	Mean sulphate g./kg.	Sulphate/chlorinity Mean	Sulphate/chlorinity Std. devn. $\times 10^4$
1	52°06′	5°43′	7	19·334	2·7002	0·13967	11
2	52°45′	4°47′	22	18·980	2·6569	0·13998	29
3	53°20′	4°46′	15	18·971	2·6531	0·13984	25
4	53°20′	5°17′	18	19·100	2·6720	0·13986	21
5	53°20′	5°55′	22	18·940	2·6532	0·14008	28
6	53°33′	3°20′	12	17·450	2·4395	0·13980	34
7	53°54′	3°31′	15	17·783	2·4842	0·13970	33
8	54°03′	4°48′	23	18·974	2·6547	0·13991	21
9	54°54′	5°27′	22	18·800	2·6291	0·13984	23
10	54°07·5′	5°22′	3	18·827	2·6412	0·14026	—
11	54°12·4′	4°50′	2	19·008	2·6597	0·13992	—
12	54°32′	5°24·4′	3	18·829	2·6419	0·14031	—
13	54°39·5′	4°42′	2	18·087	2·5312	0·13994	—
14	54°24′	3°59′	3	18·337	2·5621	0·13972	—
15	53°53′	3°33′	3	17·810	2·4808	0·14007	—
16	53°58′	4°01′	2	18·647	2·6166	0·14032	—
17	53°22′	5°17′	6	19·042	2·6615	0·13978	11
18	54°01·61′	4°42·3′	9	18·965	2·6549	0·14000	28
19	53°57·88′	4°39·5′	9	18·818	2·6344	0·13999	23
20	53°54·27′	4°36·8′	6	18·737	2·6257	0·14013	17
21	53°57·25′	4°33·7′	6	18·965	2·6572	0·14011	19
22	54°00·9′	4°36·5′	6	18·942	2·6508	0·13994	27
23	54°04·9′	4°46·8′	2	18·996	2·6611	0·14009	—
24	54°06·1′	4°47·1′	3	18·968	2·6501	0·13970	—
25	54°07·2′	4°50·1′	3	18·993	2·6603	0·14006	—
			Total 224			Weighted mean: 0·13991	Arithmetical mean: 0·13996

samples (0·13955 ± 0·00025). The difference (0·00036) may be partly attributable to the slightly different conditions of acidity used by ourselves for the precipitation of the barium sulphate.

The Sulphate-Chlorinity Ratios of Rivers flowing into the eastern Irish Sea.

The sulphate-chlorinity ratios of the non-tidal waters of 9 rivers flowing into the Irish Sea have been investigated. The ratios found (Table 4) vary greatly according to the composition of the rocks where they originate, sulphate always preponderating over chloride.

The ratio has also been determined for tidal reaches of the river Mersey (Table 5) at high and low water at three stations, by the methods used for the analysis of sea waters. As would be expected with a river subject to a high degree of chemical pollution, the SO_4/Cl ratio varies rather widely.

Table 4.

Sulphate-Chlorinity Ratio of Rivers.

River	pH	Sulphate (mg./l.)	Chloride (mg./l.)	Sulphate / Chloride
Duddon, Upper	6·95	6·33	1·44	4·40
„ Middle	7·66	6·14	1·60	3·83
„ Lower	7·11	6·12	3·72	1·65
Kent	7·30	13·04	8·58	1·52
Lune	7·25	9·34	5·03	1·86
Crake	6·89	7·96	0·89	8·99
Leven	7·05	10·30	6·46	1·59
Grisedale Beck	7·06	8·06	6·10	1·32
Ribble	7·01	17·49	4·12	4·24
Dee	7·08	5·31	4·61	11·51
Afon Ogwen	7·96	7·00	4·59	1·53

Table 5.

Sulphate-Chlorinity Ratio in River Mersey (March 1954).

Station	Tide	Depth	Cl‰	SO_4 g./kg.	SO_4/Cl
26[1])	HW	Surface[4])	15·98	2·225	0·1392
26	HW	Bottom[5])	17·06	2·384	0·1397
26	LW	Surface	14·86	2·072	0·1394
26	LW	Bottom	15·26	2·147	0·1407
27[2])	HW	Surface	14·24	2·004	0·1407
27	HW	Bottom	14·59	2·041	0·1399
27	LW	Surface	9·10	1·262	0·1388
27	LW	Bottom	13·29	1·866	0·1404
28[3])	HW	Surface	12·32	1·759	0·1427
28	HW	Bottom	12·76	1·803	0·1413
28	LW	Surface	2·12	0·272	0·1446
28	LW	Bottom	2·72	0·350	0·1640

[1]) 0·5 km. north of Rock lighthouse.
[2]) Midriver between Dingle Point and Bromborough Dock.
[3]) 0·5 km. north-east of Mount Manisty.
[4]) Surface samples taken 1 m. below water surface.
[5]) Bottom samples taken 1 m. above bottom.

Experimental.

Preparation of samples.

All samples were filtered through a fine-textured filter paper (Whatman No. 2) before analysis.

(a) Sea-water samples.

Determination of chlorinity.

The chlorinities of sea-water samples were determined on weighed 15 ml. samples by potentiometric titration (24). The silver nitrate solution was standardized with Standard Sea Water.

Determination of sulphate.

The sea water (50 ml.) was weighed out by means of a weight burette into a 600 ml. beaker, 235 ml. of distilled water were added, together with 10 ml. of saturated picric acid solution and 5 ml. of

concentrated hydrochloric acid. The solution was heated almost to boiling on an electric water-bath and 10 ml. of a hot 10 % solution of barium chloride dihydrate added with vigorous stirring. The precipitate was allowed to settle for 1 hour while the solution was kept hot. The hot supernatant liquid was decanted through a previously ignited and weighed Vitreosil sintered silica filter (porosity 4). The precipitate was transferred to the crucible with a jet of hot water and washed with small portions of warm water until the filtrate gave no opalescence with silver nitrate solution. The crucible was dried at 110°C. for 30 minutes and then heated to 800° (25) in a muffle furnace for 2 hours. After cooling in a desiccator for an hour the filter was reweighed. All weights have been converted to weight *in vacuo*.

(b) River-water samples.

The samples (2 l.) were evaporated to ca. 150 ml. in a silica basin on an electric water-bath, care being taken to avoid sulphur contamination from fumes or burners. The concentrated solution was transferred to a 250 ml. graduated flask and made up to the mark.

Determination of sulphate.

An aliquot (100 ml.) of the concentrate was evaporated to a volume of ca. 10 ml., and concentrated hydrochloric acid (0·25 ml.) was added. The warm liquid was filtered into a 25 ml. beaker and the filter well washed with small amounts of warm water. The solution, which had a final volume of ca. 20 ml., was treated with 0·5 ml. of saturated picric acid, heated to boiling, and 0·5 ml. of hot 10 % barium chloride solution added. The precipitated barium sulphate was filtered off with a porous porcelain filter crucible as described by P r e g l (26). The precipitate was washed with small quantities of hot water, alcohol, and finally ether. The filter was dried at 300° for 45 minutes, cooled in a desiccator, and weighed. Results are expressed as mg. SO_4/l.

Determination of chloride.

A further aliquot (100 ml.) of the concentrate was titrated potentiometrically with N/400 silver nitrate solution. Results are expressed as mg. Cl/l.

Acknowledgements.

The authors wish to thank Mr. D. J. S l i n n for collection of samples from Stations 10—25, and Mr. J. M u r p h y for technical assistance.

Summary.

The optimum conditions for the determination of sulphate in sea water as barium sulphate have been evaluated. The mean sulphate-chlorinity ratio for a total of 224 samples taken from 25 stations in the Irish Sea has been found to be 0·13991 ± 0·00019, in good agreement with previously reported values. There appears to be no significant difference between the various stations. The sulphate-chloride ratio of rivers flowing into the eastern side of the Irish Sea has also been investigated.

References.

1. Thompson, T. G., Lang, J. W., and Anderson, L. (1927). "The sulphate-chloride ratio of the waters of the North Pacific". Publ. Puget Sound Mar. (biol.) Stat., **5**, p. 290.
2. Thompson, T. G., Johnson, W. R., and Wirth, H. E. (1931). "The sulphate-chlorinity ratio in ocean waters". Journ. du Cons., **6**, p. 246.
3. Lewis, G. J., and Thompson, T. G. (1950). "The effect of freezing on the sulphate/chlorinity ratio of sea water". Journ. Mar. Res., **9**, p. 211.
4. Thorpe, T. E., and Morton, E. H. (1871). "Über das Wasser des irländischen Meeres". Ann. der Chemie u. Pharm., **158**, p. 123.
5. Belcher, R., and Gibbons, D. (1952). "A new reagent for the precipitation of sulphate". J. Chem. Soc., p. 4216.
6. Mahr, C., and Krauss, K. (1948). "Eine neue Sulfat Bestimmungsmethode". Zeitschr. analyt. Chem., **128**, p. 477.
7. Belcher, R., Nutten, A. J., and Stephen, W. I. (1953). "Substituted benzidines and related compounds as reagents in analytical chemistry; Part XII, reagents for the precipitation of sulphate". J. Chem. Soc., p. 1334.
8. Frey, H. (1952). "Kritische Studie über die quantitative Bestimmung von Sulfat". Anal. chim. Acta, **6**, p. 127.
9. Fischer, R. B., and Chen, W. K. (1952). "The use of benzidine dihydrochloride for sulphate determinations. II. A direct conductimetric titration method". Anal. chim. Acta, **5**, p. 102.
10. Munger, J. R., Nippler, R. W., and Ingols, R. S. (1950). "Volumetric determination of sulphate ion". Analyt. Chem., **22**, p. 1455.
11. Belcher, R., Gibbons, D., and West, T. S. (1954). "The evaluation of barium sulphate precipitates by a titrimetric method". Chem. and Ind., p. 127.
12. Tagaki, K., Shimizu, Y., and Nishino, S. (1950). "A simple potentiometric method for the rapid determination of sulphate". J. Electrochem. Soc. Japan, **18**, p. 123.
13. Horton, A. D., and Thomason, P. F. (1951). "The polarographic determination of sulphate". Analyt. Chem., **23**, p. 1859.
14. Volmer, W., and Fröhlich, F. (1944). "Die Bestimmung geringer Sulfatmengen durch Trübungsmessung". Zeitschr. analyt. Chem., **126**, p. 401.
15. Janssen, C., and Rutgers, G. A. W. (1943). "Die optische Methode zur Bestimmung des Sulfatgehaltes von Kesselwasser". Chem. Weekbl., **40**, p. 114.
16. Kolthoff, I. M., and Sandell, E. B. "Textbook of quantitative inorganic analysis". (Macmillan, New York), 2nd Edition 1943, p. 330.
17. Vogel, A. I. "A textbook of quantitative inorganic analysis". (Longmans, London), 1934, p. 583.
18. Lindsly, C. H. (1936). "Determination of sulphur in rubber compounds. I. Precipitation in the presence of picric acid". Ind. Eng. Chem. Anal. Ed., **8**, p. 176.
19. Frey, H. (1951). "Die Bestimmung des Gesamtschwefels in vulkanisierten Gummimischungen". Anal. chim. Acta, **5**, p. 375.
20. Honda, M. (1949). "Ion exchange resins in analytical chemistry. II. Nephelometric determination of sulphate". J. Chem. Soc. Japan, **70**, p. 52.
21. Thode, H. G., and Macnamara, J. (1953). "Distribution of ^{34}S in nature". Nation. Bur. Standards, Circ., 522, p. 235.
22. Trafimov, A. (1949). "Isotopic composition of sulphur in meteorites and in terrestrial objects". Akad. Doklady Nauk, S. S. S. R., **66**, p. 181
23. Proudman, J. (1946). "The salinity of the surface waters of the Irish Sea". Trans. Roy. Soc., A, **239**, p. 579.
24. Bather, J. M., and Riley, J. P. (1953). "The precise and routine potentiometric determination of the chlorinity of sea water". Journ. du cons., **18**, p. 277.
25. Peltier, S., et Duval, C. (1947). "Sur la thermogravimétrie des précipités analytiques. IV. Dosage du baryum". Anal. chim. Acta, **1**, p. 360.
26. Pregl, F. "Quantitative organic microanalysis", translated by J. Grant, (Churchill, London) 1945, p. 105.

Note on the Use of Diphenylbenzidine for the Estimation of Nitrate in Sea Water.

By

W. R. G. Atkins.

IN an earlier paper (1932) this reagent was shown to have certain advantages. There is no trouble in its preparation, such as is met with in the reduced strychnine method. The reagent, as bought, is re-crystallized from boiling toluene and the crystals remain fit for use for several years without further treatment. Its sensitivity is adequate and the colour produced is stable even when exposed to bright daylight. It suffers from the disadvantage, common to all the nitrate reagents, that use in strong sulphuric acid results in the setting free of nitric acid which attacks not only the reagent but any organic matter, so that low results may be given. With sea water this is not serious, and much of the suspended matter settles out on standing.

The rate of reaction is naturally increased by the rise in temperature occasioned by the mixing of the reagent dissolved in pure sulphuric acid, 20 mg. in 100 ml., with the water. To secure greater uniformity in the temperature from sample to sample it was recommended that 6·0 ml. of sulphuric acid should be mixed with 2·5 ml. of the sample and allowed to cool. Then 1·5 ml. of the reagent in sulphuric acid was added and mixed thoroughly, there being then very little alteration in temperature.

The method was used by Gessner (1934), Elster and Gessner (1935), Wattenberg (1937), and Riley (1939), and has also been used by Black and Dewar (1949).

It is of course necessary to allow for the nitric acid present in even the purest sulphuric acid, as bought, by adding known amounts of potassium nitrate and plotting the concentration-intensity curve found with a colorimeter. Black recommended the making up of a set of tubes containing a graduated series of convenient concentrations of nitrate. The intervals can be judged by eye approximately or comparisons can be made in a colorimeter. Black's procedure the writer has found very convenient, and it led him to the following modification which is better, simpler, and quicker than that of 1932.

It was found that the error due to reduction of nitric acid by organic matter could be greater than error due to temperature differences, as the latter could be evened out by longer standing. When the sample was mixed with pure sulphuric acid and allowed to stand, the total nitric acid, from sample and from impurity in the sulphuric acid, could, during the period of cooling, act on any organic matter before the addition of the diphenylbenzidine. If, however, the latter were dissolved in the acid and 7·5 ml. of the mixture were run into a tube, and 2·5 ml. of the sample added and stirred, then the very easily oxidized reagent was effective in removing the nitric acid more rapidly than could the particulate organic matter. The reaction of both the reagent and the organic matter also proceeds more rapidly owing to the heat of the mixture, whereas in the former technique only the organic matter had this advantage.

It should be remembered that the blue colour due to the reaction between the reagent and nitric acid is an oxidation product, not a nitration; it is given by any oxidizing agent. Bearing this in mind the writer has found diphenylbenzidine a very useful reagent for the testing of river- and well-waters for potability in the course of his duty in charge of a Mobile Hygiene Laboratory during the recent war. The reaction is much quicker than that on heating with phenol in sulphuric acid to produce picric acid, which is, however, a nitration product.

For the removal of traces of nitric acid from the purest bought acid, several methods have been suggested. Small amounts may be removed by warming the acid first. One of the bought samples which proved almost entirely free from nitric acid was obtained from a local acid works without any guarantee of high purity!

The writer tried (1932) the cautious addition of sulphuretted hydrogen, which on oxidation left only a very slight turbidity due to sulphur. Ramachandran (1948) suggested heating the acid with a very little formaldehyde. This goes to formic acid, which is harmless, and should leave no turbidity, after heating, to destroy any discoloration that occurs.

By this method Ramachandran obtained a nitrate/nitrogen blank of from -2 to $+2$ mg./m^3. in his sulphuric acid (private communication).

It is also possible to add 2 g. per litre of ammonium chloride to the sulphuric acid and to decompose the resulting ammonium nitrate by heating to 180°C. for an hour, nitrogen being liberated (Pfeilsticker, 1932).

References.

Atkins, W. R. G., 1932. "Nitrate in sea-water and its estimation by means of diphenylbenzidine". J. Mar. Biol. Assoc. U. K., **18**, 167—192.

Black, W. A. P., and Dewar, E. T., 1949. "Correlation of some of the physical and chemical properties of the sea with the chemical constitution of the algae". ibid., **28**, 673—699.

Elster, H. J., and Gessner, F., 1935. "Die chemische und biologische Sommerschichtung im Bodensee". Inst. f. Seenforsch. u. Seenbewirtsch. Langenargen.

Gessner, F., 1934. "Nitrat und Phosphat im Dystrophen See". Arch. f. Hydrobiol., **27**, 131—161.
Pfeilsticker, K., 1932. "Colorimetric determination of nitrate with diphenylamine or diphenylbenzidine". Zeitschr. analyt. Chem., **89**, 1—8.
Ramachandran, B. V., 1949. "Preparation of nitrogen-free sulphuric acid". Nature, **162**, 450.
Riley, G. A., 1939. "Plankton studies; II. The Western North Atlantic, May—June 1939". Sears Found., J. Mar. Res., **2** (2), 145—162.
Wattenberg, H., 1937. "Critical review of the methods used for determining nutrient salts and related constituents in salt water". Cons. Internat. Explor. Mer, Rapp. et Proc.-Verb., **103**, 5—33.

Colour Filters to Simulate the Extinction of Daylight in the Sea.

By

N. G. Jerlov.

A classification of sea waters has been made with respect to transparency to daylight (Jerlov, 1951). Tables 1 and 2 embody the normal transmission values for 7 types of coastal water and for 3 types of oceanic water respectively. A significant feature is that the transmission from one water type to the next is more reduced in the short-wave than in the long-wave range as a result of the selective action of yellow substance and suspended particles.

Photochemical processes in the sea — for instance, photosynthesis — are often studied not only *in situ* but also through parallel experiments in the laboratory. The question arises whether the optical properties of sea water may be simulated by artificial means. Is it possible to produce the light extinction caused by one metre of a certain type of water with the aid of a colour filter or of some combination of colour filters? An attempt has been made to arrive at such a result with Schott and Gen. colour filters. The filters chosen are listed in Tables 1 and 2.

As regards ocean waters I, II, and III, which are very transparent to blue, adaptation to them is readily obtained with the aid of filter BG22 of different thicknesses. These glasses are more or less corrected by filter BG14, which reduces the transmission of the long wave-lengths.

The same main filter is not appropriate for the group of coastal waters, since the position of their maximum transmission is shifted considerably, from 500 mμ (Type 1) to 565 mμ (Type 7). A suitable filter for Type 1 is a 2·8 mm. BG9, the spectral transmission of which is very similar to that of Type 1. In other cases two or three filters are required. Type 2 is also produced with BG9 as the main filter, whereas for the remaining waters BG22 is again suitable. The short wave-lengths are absorbed by GG4 or more strongly by GG6. It was found necessary to add a non-selective glass, NG6, in the Type 4. Adaptation to the last

Table 1.

Normal transmission values (%) per m. for coastal waters and with the sun at an altitude of 45°, compared with transmission values for simulating combinations of colour filters (Schott & Genossen).

Type of coastal water	Filter combination mm.	Wave-length mμ 400	450	500	550	600	650	700
1		70	85	89	87	75	63	39
	2·8 BG9	70	85	89	86	76	63	43
2		64	82	87	85	74	61	37
	3 BG9 + 0·1 GG4	62	83	87	85	74	61	39
3		54	76	82	81	72	58	33
	3 BG22 + 0·4 GG4	50	77	82	81	73	57	39
4		45	68	77	77	69	55	29
	3 BG22 + 0·7 GG4 + 0·4 NG6	35	68	76	77	69	53	35
5		37	60	71	72	67	52	26
	3·5 BG22 + 0·3 GG6 + 0·8 UG10	46	62	70	72	67	51	33
6		29	52	64	68	65	49	23
	3·5 BG22 + 0·5 GG6 + 1·3 UG10	33	50	64	68	64	50	32
7		22	42	57	64	63	47	21
	3·5 BG22 + 0·7 GG6 + 1·6 UG10	22	41	59	64	62	49	31

three types 5, 6, and 7, is accomplished only by UG10, the highest absorption of which is for green.

The essential conformity attained in the range of maximum transparency between water type and filter combination is satisfactory in all cases. Deviations occur at 400 mμ, but they are negligible errors in the total transmitted radiation. All filter combinations transmit somewhat more at 700 mμ and much more in the infra-red than does water. This effect is considered below.

The calculations are based on data given by Schott and Gen. in their list of transmission values. It must be observed that one of the filters, GG6, shows manufacturing variations in colour of the particular glass-melt.

Table 2.

Normal transmission values (° o) per m. for ocean waters and with the sun at the zenith, compared with transmission values for simulating combinations of colour filters (Schott & Genossen).

Type of ocean water	Filter combination mm.	Wave-length mμ 375	400	450	500	550	600	650	700
I		96·3	97·2	98·1	97·2	94·2	85	70	58
	0·2 BG22 + 0·4 BG14	95·3	96·8	98·3	97·5	93·8	83	70	61
II		89	92	94	93·5	90·5	80	67	—
	0·9 BG22 + 0·3 BG14	86	92	94	94	90	81	68	54
III		79	84	88·5	89	86·5	75	63	—
	1·8 BG22 + 0·2 BG14	76	84	89	89	86	77	61	46

The non-selective reflexion losses for the glass-air surfaces have not been taken into account. It is advisable to use, for instance, a film of cedarwood oil between the filters, which practically eliminates internal reflexion losses in the filter combination. Light penetrating a series of such filters constructed to simulate a certain water column is reduced by reflexion only at the first and last surfaces, i.e., by 8 %.

It may be emphasized that the filter combinations behave in the same way as water in the visible region but they transmit a certain amount of infra-red, which is absorbed by water. In consequence, a filter which cuts off the infra-red must be added to them. The infra-red screening of the radiation from sun and sky is achieved by means of a 3 mm. BG17 filter, which brings the transmission of wave-lengths above 700 mμ by the filter combinations into conformity with that of water.

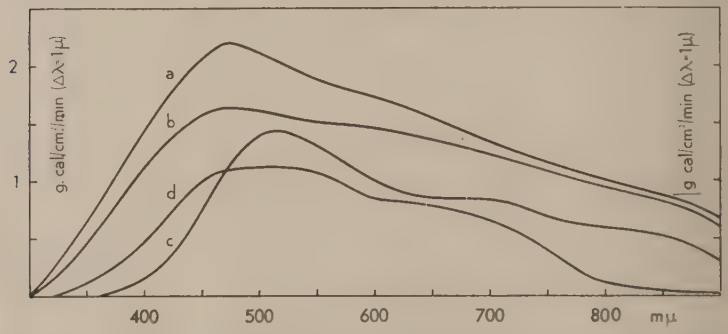


Figure 1. The spectral distribution of radiation from sun and sky. Curve **a** represents clear sky and the sun at the zenith; Curve **b**, clear sky and the sun at an altitude of 45°; Curve **c**, the sky covered with dense clouds (9 g./cm.²) and the sun at an altitude of 20° (A l b r e c h t, 1936). Curve **d** shows the spectral distribution of radiation at a distance of 10 cm. from an incandescent tungsten lamp (250 W, colour temperature 2840°C.) provided with 2 mm. BG19 +1·5 mm. BG14 + 0·3 mm. BG24 filters. The left-hand scale refers to Curves **a** and **b**, and the right-hand scale to Curves **c** and **d**.

The spectral energy of daylight is illustrated in Figure 1. Curve **a** represents clear sky and the sun at the zenith; Curve **b**, clear sky and the sun at an altitude of 45°; and Curve **c**, the sky covered with dense clouds (9 g./cm.²) (A l b r e c h t, 1936). If an artificial light source be used, its energy distribution should be modified so as to become a compromise between the distribution with a clear sky and that with an overcast sky. This may be exemplified by an incandescent tungsten lamp of 250 W. Its emission exhibits an energy maximum at about 1000 mμ (colour temperature 2840°C.), from which the energy falls rapidly towards the shorter wave-lengths. This distribution is modified with 2 mm. BG19 + 1·5 mm. BG14 + 0·3 mm. BG24, BG 19 being most effective in eliminating the infra-red. The resulting energy at a distance of 10 cm. from the lamp filament is in accordance with Curve **d** and somewhat less than the daylight energy with an overcast sky (Curve **c**).

Precautions must be taken with the filters which absorb infra-red. It is advisable to expose their whole area so that they are evenly heated. They should be well ventilated and loosely mounted so as to allow expansion.

Table 3 gives an idea of the percentage amounts of total energy obtained with the suggested arrangement of corrected lamp + filters. Because the infra-red is already excluded from the light source the percentages at a depth of one metre are twice as high as those given

Table 3.

Percentage amounts of total energy from a lamp at different depths of water simulated by colour filters.

An incandescent tungsten lamp (250 W) corrected with 2 mm. BG 19+1.5 mm. BG 14+0.3 mm. BG 24.

Depth	Oceanic water			Coastal water						
m.	I	II	III	1	2	3	4	5	6	7
0	100	100	100	100	100	100	100	100	100	100
1	84	80	75	70	67	64	59	54	49	45
2	74	66	58	52	48	43	38	33	28	23
5	56	44	32	27	23	18	13	8·9	6·3	4·5
10	41	27	14	11	8·2	5·2	2·7	1·3	0·70	0·36
15	33	18	6·8	5·3	3·3	1·7	0·64	0·24	—	—
20	28	12	3·5	2·5	1·4	0·56	—	—	—	—
25	24	8·0	1·8	1·2	0·56	—	—	—	—	—
30	20	5·6	1·0	0·57	—	—	—	—	—	—
40	15	2·7	—	—	—	—	—	—	—	—
50	11	1·3	—	—	—	—	—	—	—	—

earlier for daylight, for different water types (Jerlov, 1951, Table 32). Below one metre, however, the decrease of the total energy with increasing depth shown in Table 3 is almost identical with that of daylight. The values in the table are valid for a moderate change in the colour temperature of the lamp.

References.

Albrecht, F., 1936. Handb. d. Meteor. Inst., Leipzig.
Jerlov, N. G., 1951. "Optical studies of ocean waters". Rep. Swedish Deep-Sea Exped., 3, 1.

Distribution of Laminariaceae around Scotland.

By

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FIFTY-NINE detailed surveys, covering 80,000 acres of the sub-littoral zone off the north-eastern, south-eastern, and south-western parts of the mainland of Scotland, the Isle of Skye, and several of the islands of Orkney have been completed by the Botanical Division of the Institute of Seaweed Research. The detailed surveys were preceded by aerial photogrammetric surveys. The surveys were carried out at all times of the year during seven years, 1946 to 1953, and so include seasonal and perennial changes. The surveys covered areas of the sea bed from low-water mark down to 10 fathoms (19 m.) where the dominant species was either *Laminaria cloustoni*, *L. digitata*, or *L. saccharina*. (Some surveys were restricted to depths from 1 to 6 fathoms.)

Tidal streams ranged from 0 to 7 knots, and tides from L. W. M.[1]) to 3 fathoms (6 m.) above according to time and location.

In the course of the 59 surveys, operated from motor vessels, some 50,000 quadrats were taken from the sea bed by means of calibrated spring-grabs which close by trigger action on reaching the bottom (1). The 1946 to 1949 surveys employed methods of quadrat sampling along transects measured by rangefinder, while for the 1949 to 1953 surveys, random sampling was used; random sampling is less dangerous inshore. Nevertheless, this method can attain considerable accuracy; standard errors of 1—2 per cent. of the mean, when the intensity of sampling was only 100 quadrats per square kilometre, were achieved.

The mean of the means (which we term the master mean) of "density" and "cover" found at each depth for the 59 surveys is given in Table 1 and in Figure 1.

"Density" is the average fresh weight of species of *Laminaria* per unit area, *based on quadrats which contained these algae*. "Cover" is the number of quadrats which contained laminariae expressed as a percentage of all quadrats; it indicates the area of the sea bed colonized by the Laminariaceae.

[1]) Low-water mark.

Table 1.

Depth L. W. M., O. S. T. (fathoms)	Density Master mean of 59 surveys (based on quadrats with laminariae) (lb. sq. yd.)	(kg. sq. m.)	Cover Master mean of 59 surveys (%)
1	11·0	6·0	76
2	10·3	5·6	72
3	8·8	4·8	65
4	7·5	4·1	57
5	6·2	3·3	48
6	5·3	2·9	44
7	4·7	2·5	35
8	3·3	1·8	28
9	2·7	1·5	21
10	2·3	1·2	18

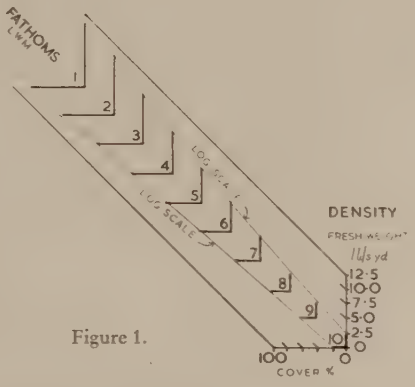

Figure 1.

Figure 1. The master means of the "Density" (vertical lines) and the "Cover" (horizontal lines) of 59 detailed sub-littoral surveys around the coast of Scotland during the years 1946 to 1953 inclusive, from 1 to 10 fathoms.
The density log.scale is $\log_{10}$ 1·1600—0·0770 per fathom, which most closely fits the results, and the cover log.scale is calculated from the density/cover constant of 13·14.

From the data above, it will be found that firstly, the value for density divided by the respective value for cover is a good approximation to a constant for each fathom interval of depth from 1 to 10 fathoms, L. W. M., O. S. T. The density/cover values for the 10 depths is 13·14 with a standard deviation of 0·9 and a standard error of 2 per cent., with lb./sq.yd. as the unit of density. The fresh weight of laminariae is therefore proportional to the percentage cover. This relationship has been reported for many individual surveys (2, 3, 4, 5).

Secondly, the seaweed densities given in Table 1 follow an exponential regression with increasing depth of sea, which, calculated from L. W. M., O. S.[1]), on $\log_{10}$ equals 1·1600—0·0770 per fathom and on $\log_e$ equals 2·6700—0·0960 per metre. As the cover is proportional to the density, then the cover must be exponential also with depth.

Seaweed growth is the result of photosynthesis. Should daylight be the limiting factor, we would expect the growth of Laminariaceae to be exponential with increasing depth of sea, for the coefficient of extinction of the visible solar spectrum is similarly logarithmic. As the area covered by the species of laminariae has been shown above to be proportional to the density at various depths, then cover should be proportional to the standard deviation of the mean density.

During 1949 to 1953, 28 sub-littoral surveys were carried out by methods of random sampling and from the data the cover and the standard deviation of the mean density were calculated for each fathom interval of each survey. The mean cover (%) is plotted against the associated standard deviation of the density (lb./sq.yd.) in Figure 2.

[1]) Low-water mark, ordinary springs.

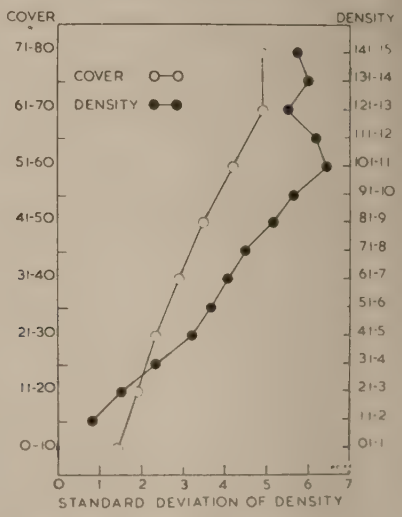

Figure 2. The mean of the Cover from each fathom interval of depth of each of 28 sub-littoral surveys against the associated standard deviation of the mean of density. The master mean of the density is also plotted against the corresponding standard deviation.

It will be seen that from 0 to 70 % the cover is proportional to the standard deviation of the mean of the density per quadrat of 1 sq.yd.; the progression is linear, amounting to 0·5 for each 10 % increase in cover.

The mean density from 1 to 11 lb. also follows a linear progression with the standard deviation of the mean of the density, being 0·5 for each increase of 1 lb./sq.yd.

Seaweed cover and density of the Laminariaceae are thus further shown to be related through the standard deviation of the mean density.

In the more recent surveys, the number of plants per quadrat has been recorded and the decrease in seaweed density has been found to be more a result of a reduction in the number of plants per unit area than of the weight of individual plants.

From these results it may be concluded that the algal cover is conditioned by the frequency and spread or, in other words, the distribution of the algae which, in turn, is the result of photosynthesis-reproduction-dispersion. It follows that with increasing depth, the total spore production will be decreased, dispersion and fertilization reduced, and the plant cover limited. This last conclusion requires the development of the spores to proceed at nearly the same depth of sea as that at which the parent plant is or was growing.

Time has been available for the analysis of only a limited number of surveys by the application of the χ^2 test to samples and their fresh weight distributions. The data of some surveys fit normal distributions, others do not. For example, a survey carried out between Girvan and Bennane Head in the approaches of the Firth of Clyde during May 1952 indicated that the frequency and spread of the samples had a normal distribution for each depth from L. W. M. to 6 fathoms. An

identical survey, carried out in the following October—November, after severe gales had reduced the total quantity of seaweed by 34 %, showed the samples no longer conformed to normal distributions when the χ^2 test was applied.

The aerial survey of the sub-littoral zone of Scotland (started in 1945) in conjunction with the results obtained from detailed surveys, such as the relationship of seaweed density and cover, has enabled me to assess the total growth of Laminariaceae from aerial photographs. Since the first assessment was made in 1950, it is now known that changes are occurring over periods of years. The following are examples:

Seasonal	Density (tons/acre)	Cover (%)
Arran-west (mixed *L. cloustoni* and *L. saccharina*)		
1953 February—March	2·4	33
May—June	6·3	55
August	6·7	56
Fraserburgh — Rosehearty (*L. cloustoni*)		
1952 January	10·1	76
June	10·7	70
September—October	9·3	71
Dunbar — Fast Castle (*L. cloustoni*)		
1952 April—May	5·7	51
July—August	6·2	53
Perennial		
Arran-east, north, west (mixed *L. cloustoni* and *L. saccharina*)		
1952 January—February	4·7	32
1953 do.	2·9	41
Girvan — Bennane Head (*L. cloustoni*)		
1952 May	18·1	75
1953 do.	10·9	61
North Shapinsay, Orkney (*L. saccharina*)		
1951 July	9·5	52
1952 do.	5·6	35
1953 do.	6·6	48
Fraserburgh — Rosehearty (*L. cloustoni*)		
1952 September—October	9·3	71
1953 do.	5·1	48

With this further knowledge, a re-assessment of the total seaweed resources of Scotland was made in 1954. The results are as follows:— the marine coast of Scotland and Islands is 5300 miles[1]); the sub-littoral zone from low-water mark to 10 fathoms (19 m.) is 2 million acres;

[1]) Does not include minor islands and inlets; with these the length is 6750 miles.

over this area, with considerable variation in seaweed density, grow 10 million tons (fresh weight) of Laminariaceae. Of this quantity, 3 to 4 million tons are concentrated in quantities of potential economic value and located in areas shown in Figure 3, to which Table 2 serves as an index.

In conclusion it may be of interest to compare the mean density of Laminariaceae found over the last seven years around Scotland in terms of the energy of photosynthesis. By extrapolation to low-water mark of the log. scale of density (Figure 1) it is found that the density is 8 kg./m^2. This is equal to 1·1 kg./m^2. of carbon dioxide per annum (some parts of the laminariae are the result of more than one year's growth). To photosynthesize this amount of carbon dioxide at a rate of 8 quanta of the visible spectrum per molecule requires $1{\cdot}4\times10^7$ cal./m^2./a. The average amount of solar energy of the visible spectrum at normal incidence during a 12-hour day reaching the earth's crust is 1×10^9 cal./m^2./a. The efficiency of the Laminariaceae to photosynthesis is therefore 1·4 %. The energy conversion yield of plant pigments is 2 % of the visible spectrum (6).

Figure 3. The distribution of the Laminariaceae around the coast of Scotland. The key to location, quantity, etc., is Table 2.

Table 2 (Key to Figure 3).
Areas of Scotland where Laminariaceae occur in quantity and concentration to be of economic value.

Map ref.	Locality Survey place name	Quantity 1000 tons	Area 1000 acres	Coast miles
A	Shetland	610	56	700
B	Orkney	1,200	56	500
C	Outer Hebrides	700	41	85
D	Enard Bay — Lochalsh	122	24	160
E	Skye	300	18	220
F	Tiree and Coll	302	20	58
G	Mull	20	2·3	15
H	Colonsay	20	2	6
I	Islay	50	4	11
K	West Kintyre and Gigha	200	11	50
L	Arran	56	6·8	48
M	East Kintyre	40	2·6	22
N	Girvan	44	4·2	21
O	Luce Bay	20	1·6	4
P	Dunbar	50	3·4	11
Q	Crail	22	1·3	7
R	Fraserburgh	60	18	60
S	Tarbat Ness	10	1·6	8
T	Helmsdale	22	2·9	10
U	Loch Eriboll	20	1·3	13
		3,868	276	*2009
		39 % of 10 million tons	14 % of 2 million acres	38 % of 5300 miles

*) This length of coast does not support seaweed continuously.

When we take into consideration that the sunlight is not of normal incidence in Scotland; that much of the time direct sunlight is scattered by clouds; that respiration is utilizing some of the products of photosynthesis; that erosion of frond is taking place; then the figure of 1·4 % is of the order which one would expect.

Summary.

From 1946 to 1953, detailed surveying of the Laminariaceae around Scotland has shown that the density (fresh weight per unit area) is related to the area colonized by these species.

The density of the algae is exponential with depth.

Seasonal and perennial changes have been noted, and an assessment of the total resources of Laminariaceae around Scotland has been made.

Acknowledgements.

I wish to put on record the conscientious work of sampling the sea bed carried out at various times during the last seven years by the crews of the m. v. "Argo", m. v. "Ella", m. v. "Jean", m. v. "Teresa",

m. v. "Bairns Pride", and m. v. "Bengullion". The co-operation of the Royal Air Force and Air Cover Library, Department of Health, Scotland, is gratefully recorded herewith.

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During the last war, a superficial survey of the Laminariaceae of Britain was carried out by V. J. Chapman, R. Richens, G. Fogg, and R. Lewin.

Details of the survey have not been published but a summary appeared in 1948 (*Economic Botany*, **2**, p. 363) and the quantities given on the map amount to 790,000 tons of Laminariaceae around the mainland of Scotland with the islands Skye and Mull.

The corresponding value found by Walker is 930,000 tons; these figures are in fair agreement but the quantities for individual areas are not, where they can be compared.

Chapman also estimates 576,000 tons for the Orkney Islands, Walker finds twice this quantity, but both agree on the value for the Outer Hebrides.

The Chapman surveys have a maximum probable error of 50 %; Walker has worked within a probable error of 5 %.

References.

1. Walker, F. T. 1947. J. of Ecol., **35**, 166.
2. — 1948. Nature, **161**, 977.
3. — 1950. J. of Ecol., **38**, 139.
4. — 1953. J. of Ecol., **40**, 74.
5. Walker, F. T., & Richardson, W. D. 1953. (presented for publication).
6. Rabinowitch, E. I. 1951. *Photosynthesis and Related Purposes.* Vol. 1.

Engineering and Economic Aspects of Marine Plankton Harvesting.

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Introduction.

During the past few years it has been suggested on several occasions that marine plankton could be used to supplement our food resources and possibly as a raw material for the chemical industry (1, 2, 3, 4). It has also been stated that the primary obstacle to the implementation of such a scheme is the difficulty of harvesting, and several suggested means of overcoming this difficulty have been put forward.

There is, however, no indication that the problem has been examined from the engineering and economic viewpoints, and it is with this object in view that the present study has been made. There can be little doubt regarding the technical feasibility of harvesting, although none of the methods so far propounded adequately covers this aspect of the problem; but the obstacles to its economic feasibility are formidable. During recent discussions in the House of Lords on the problem of finding food for the world's increasing population, Lord Samuel is reported as having said that "plankton can be had for the asking". This popular misconception that materials from the sea are available at little or no cost has no foundation in fact, since recovery conditions usually impose a high charge on the product. Plankton is no exception.

I am indebted to Dr. D. H. Cushing, Dr. J. H. Fraser, Mr. Michael Graham, C. M. G., Professor A. C. Hardy, F. R. S., Dr. C. E. Lucas, F. R. S. E., Mr. F. S. Russell, F. R. S., Mr. R. S. Wimpenny, and Dr. F. N. Woodward, F. R. S. E., for their very helpful criticisms during the preparation of this paper.

Review of Suggested Methods.

Suggested or used methods of collecting plankton include various forms and arrangements of tow net (5, 6), nets arranged to swing with the tide (1, 2), a clarifier-type centrifuge (3), rotating screens (7), and the filtration of condenser water in large steamships.

The primary drawback to the use of tow nets for harvesting on a large scale would be the fairly rapid drop in filtering efficiency caused by the "catch" plugging the fine mesh of the net. This presupposes that the catch *en masse* is compressible. The practical effect would be to necessitate frequent hauling and clearing of the nets, resulting in a relatively long cycle of operations compared with the time occupied in netting the plankton from the sea. In addition, it would be difficult to determine the most effective length of tow; if too short, the harvesting rate would be relatively small, and if too long, part of the tow would be wasted and valuable harvesting time lost. These losses could assume significant proportions over long periods of operation, and would militate against the economic practicability of the method. In any case, the plankton population density is so variable with time and place that it would be quite impossible to estimate an optimum length of tow that would be universally applicable or, consequently, to design for continuous operation at, or near, maximum efficiency.

Similarly, it would be impossible to determine the optimum operational period for swing nets and these would have the added disadvantage of comparative immobility, unless operated from boats. In the latter event, the swing net system would incorporate all the disadvantages of tow nets with few, if any, of their virtues.

The use of large tow nets in conjunction with a pumping system for continuous withdrawal of the catch would give little improvement over a simple net system. Its effectiveness would be limited by the maximum quantity of water which could, economically, be pumped through the suction pipes and, to a lesser though significant extent, by the difficulties in handling the gear during shipping and unshipping operations. A somewhat similar system has been considered for use in the harvesting of brown algae from the sea bed (8, 9) and experimental work has shown that both these factors have a profound effect on the practicability of the system. In its proposed application to plankton harvesting no quantities or pipe sizes have been specified, but H a r d y, in a private communication, suggests five 10-ft. diameter nets with a suction pipe from the cod-end of each discharging into a common header of appropriately increasing diameter. If we assume a 6-in. diameter pipe from each net, a header of 14-in. maximum diameter, and a boat speed of 2 knots, then the maximum capacity of the suction system would be of the order of 4,000 gallons/minute, or about 1 % of the total quantity of water entering the five nets. The outflow of the bulk of this water would therefore be through the mesh of the nets, giving a flow pattern tending to prevent movement of the "catch" to the cod-end and causing rapid choking of the mesh as in a simple tow net system. Increasing

the suction pipe area to counteract this tendency would be quite impracticable. Even the system specified above would present very serious handling problems and a considerable risk of permanent deformation of the suction pipe due to "kinking".

To use a ship solely for the harvesting of plankton would result in very high operating costs (in the case of a trawler about £ 115 per day at present rates), compared with the low weight of the anticipated catch, even under the most favourable conditions. Relatively small boats could possibly be used in certain areas, but this would introduce yet another factor into the already complex problem of selecting a suitable harvesting area. It is no doubt for these reasons that it has been suggested that plankton might be recovered from the condenser water pumped by steamships, which in large passenger liners, may be as much as 200 tons per minute. There would, however, be difficulty in implementing such a proposal unless the ship was specially designed for the purpose, since a filtration plant to deal with such large quantities of water would be incapable of being housed in a modern liner, where space economy is an important design feature, without drastic modification. Also it would be purely coincidental if the liner's normal course took it through plankton-rich areas, and the cost of any course alteration for plankton harvesting would impose a prohibitive charge on the harvest.

In 1942 Shropshire (7) conducted a series of experiments with tow nets, sand filters, flocculation and settling techniques, and centrifugal devices, all of which he rejected as "impractical for either physical or economic reasons, or both". He subsequently conceived the use of a rotary screen type of machine, similar to those used in the clarification of water supplies and effluents (10), and constructed and tested two such machines. On the basis of these tests he claims that this type of machine meets most of the requirements of a plankton collecting system, which he defines as "sturdiness, continuity of operation, relatively low cost from the standpoint of either original installation or maintenance, and the capacity for handling large quantities of sea water in a reasonable length of time".

For successful and continuous operation under actual sea conditions, however, it would be necessary to devise a more effective means of collecting the solids backwashed from the screen to prevent loss due to wave action and splash, and a suitable continuous conveyor between the machine and the shore or an attendant boat. In the prosecution of these designs, many inherent difficulties would be encountered, and more fundamental information on the filtering and flow characteristics of the catch than is at present available would be required. For example, until we know the density, particle size and compressibility of the solids, the resistance of the "catch" to filtrate flow, the coefficient of viscosity of the "catch", etc., it is impossible to design for the most economic operation of the unit.

There seems to be little point, however, in pursuing these lines since two other important factors militate against economic harvesting by this method: (a) there are few, if any, localities where there is sufficient

plankton regularly to justify continuous operation of a machine designed to harvest from a "fixed" position by utilizing tidal flows (11); and (b) the capital cost of the unit, compared with the low harvesting rate, would impose a crippling interest and depreciation charge on the harvest.

It is difficult to estimate this cost since Shropshire gives no indication of what he has in mind for automatic and continuous removal and transportation to shore of the "catch". It is unlikely, however, that a machine of the type proposed, properly designed to operate under the relatively arduous conditions in tidal estuaries, together with its ancillary equipment, could be produced for less than £ 4,000. Since, during long periods of operation in most localities, it is likely that there would be no plankton at all, one can assume a very low average population density. For the purposes of costing, assume this to be 0·01 g. (dry weight) per cubic metre, or one-tenth of the density in a "rich" area as defined by Clarke (1). Then the interest and depreciation charge per ton of product using a machine on the lines suggested by Shropshire, operating for 2,000 hours per year, would be at least £ 4,500 per dry ton of plankton!

Costs.

There is insufficient information at present available for the accurate assessment of the cost of harvesting plankton by the methods suggested, but by assuming (a) an average population density of 0·1 g. (dry weight) per cubic metre (1) for mobile harvesters, and 0·01 g. (dry weight) per cubic metre for "fixed" harvesters in tidal estuaries, (b) 2,000 hours harvesting per year, (c) 200 hours travelling to and from harvesting areas (where applicable), and (d) a 20 % straining efficiency for large tow nets (12, 13) (probably on the low side) and 90 % for small nets or filter fabric in non-towing methods where a finer mesh can be successfully used, a very rough approximation is possible.

The correlation of the cost of operating a ship, the principal item in the total cost of harvesting, with the anticipated maximum theoretical rate of procurement in a "rich" area, gives a rough guide to the minimum cost per unit weight of plankton which would result from harvesting by tow net methods . Using a 60-ft. motor fishing vessel, for example, for 2,200 hours would cost about £ 3,600 (wages — £ 1,700; fuel, etc. — £ 560; maintenance — £ 300; interest and depreciation — £ 1,040) and, using the number of nets indicated, would give the following very approximate costs per dry ton of plankton:—

Method	Estimated*) maximum catch (dry tons per 2000 hrs.)	Approximate cost per dry ton of plankton £
6 2-metre stramin nets fished alternately	1·8	2,000
2 4½-metre nets fished alternately	2·0	1,800
2 Helgoland larva nets fished alternately	1·0	3,600
2 10-ft. dia. nets fished alternately	2·0	1,800

*) Based on information from D. H. Cushing.

A boat of the "m. f. v." (motor fishing vessel) type would, however, be very limited in both its range of operation (which may limit its use to areas of comparatively low population density at least for a part of its operational period) and its capacity (which would prevent full advantage being taken of the higher population density in a "rich" area). It is probable, therefore, that the cost per ton of plankton would be even higher than indicated above.

The advantages of increased mobility and higher capacity of a larger boat are largely offset by the increased cost of operation. The cost of operating a trawler for 2,200 hours is about £ 25,000, and fishing ten 10-ft. diameter nets, five at a time, as suggested by H a r d y, would give an estimated maximum "catch" of about 10 tons at a cost of approximately £ 2,500 per dry ton.

In methods employing equipment in fixed positions one would expect the costs to be even higher, because of the much lower anticipated average population density. On the basis of the assumptions already made, the costs per dry ton of plankton, taken by swing nets and rotating screen machines, would be in the region of £ 6,000 and £ 10,000, respectively.

According to J o h n s t o n e (14), the analysis of a typical zooplankton catch consisting chiefly of copepods gave: fat, 7 %; protein, 59 %; carbohydrates, 20 %; and chitin and ash, 14 % (dry basis). It will be seen therefore that the lowest possible cost on a protein basis would be of the order of £ 3,000 per ton. The comparable figures for various species of fish landed in Scotland calculated from the average first-hand prices during 1953, and the data published by R e a y, C u t t i n g, and S h e w a n (15), show that the highest priced fish on a protein basis is only about one-twentieth of this cost. Similarly, on a fat basis the cost of plankton is considerably in excess of the highest priced fish.

It might be argued that there are exceptionally rich areas of plankton where the population density is in excess of the figure used in the above cost estimates, but at least a twenty-fold increase in this figure would be necessary to give costs, on a protein basis, comparable with those in the fisheries industry. Such areas would therefore require to have an *average* population density of at least 2 g. (dry weight) per cubic metre before the harvesting of plankton could be regarded as an economic proposition.

It would appear therefore that none of the methods so far proposed is suitable for the harvesting of plankton at an economic cost.

Discussion.

Careful attention to design details would probably effect some reduction in cost but, in the writer's view, the principal causes of the high cost are to be found in the extraordinary conditions under which the harvesting operations must be conducted. Let us consider these conditions.

Before the process industries would plan for the exploitation of a new raw material, they would require assurances that it could be made available in regular supply, in quantity appropriate to the size of the industry, and at a price which would permit processing at an economic level.

One of the first difficulties would be that occasioned by the quite considerable fluctuations in population density with time, place, and depth (16, 17, 18). Since most of the factors responsible are themselves variable and largely interdependent, the mechanism by which they influence the population density is complex and, at the present state of knowledge, not susceptible to mathematical treatment. In these circumstances, it would be impossible to predict the magnitude or density of the plankton population in any particular sea area. Valuable time may therefore be lost in searching for areas of high population density, and this would have a profound effect on the economics of harvesting, particularly since no efficient and quick method has yet been devised for this purpose. Echo-ranging and echo-sounding devices, developed for the detection of fish shoals (19, 20), have provided a very effective means of overcoming this difficulty in the fishing industry, but it is difficult to see, at the present stage of knowledge, how a similar technique could be applied in the detection of planktonic organisms.

Another, and more formidable, problem is presented by the very low average population density. Clarke (1) states that 0·1 g. (dry weight) of plankton per cubic metre of sea water can be taken as a maximum figure, but Hardy (2) considers that some areas off the west coast of Scotland may give a greater yield. Cushing, in a private communication, defines the continental slope of North America between Cape Hatteras and the Bay of Fundy, the region between the North Sea and Faroe Shetland Channel with its approaches, and possibly a limited region to the north of Labrador, as "rich" regions where, he states, one may expect to find 0·05 g. (dry weight) per cubic metre or more during the summer. In the circumstances discussed above, it is difficult to see how such a prediction can be made, but the important point is that 0·05 g. (dry weight) per cubic metre is evidently considered to be a "rich" concentration.

If we take even the maximum figure specified by Clarke (1), it would be necessary to filter about 1,000,000 gallons of water to recover 1 lb. of plankton. Considered purely as a filtration problem, such a concentration, when the residue is the valuable material, is quite exceptional and, unless motivated by some special condition such as world shortages or a very high priced product, would not merit further consideration.

The "catch" would vary in composition, and may include both phytoplankton and zooplankton in differing proportions. Clarke (1) states that in the oceans as a whole "phytoplankton must bulk larger than zooplankton, since the latter subsist upon it". Juday (3) puts the proportion of zooplankton at "not more than 10% of the total and frequently as little as 5%". The larger size of the zooplankton,

however, makes possible the use of stronger nets, giving larger filtering areas, and permitting higher towing speeds than are possible with the fine-mesh nets required for phytoplankton collection. At the same time, the average size of solid retained by a filter fabric is usually considerably finer than the mesh of the fabric, since the real filtering medium is the cake of solids deposited (21, 22). Therefore, unless operations were conducted at depths below the photosynthetic zone, some phytoplankton would still be included in the "catch", and in taking advantage of the diurnal vertical migration of many plankton animals (17) by fishing near the surface during the hours of darkness, one would expect the proportion to be significant. Besides complicating the subsequent processing of the plankton, this would increase the compressibility of the catch, and cause more rapid "plugging" of filtering devices.

In addition, bad weather conditions and seasons of low concentration may seriously interfere with the continuity of harvesting, and result in long periods of inactivity. In the cost estimates quoted earlier it has been assumed that alternative uses would be available for the boats when they were not required for plankton harvesting, and maintenance, interest on capital, and depreciation charges have been appropriately reduced. It is most unlikely that this could be arranged in practice and, in consequence, it is almost certain that there would be a significant increase in these costs. It might be argued that by chartering the necessary boats for harvesting, the cost of idle periods could be almost eliminated but if this procedure were adopted it would be impossible to guarantee adequate harvesting capacity when it was needed or consequently to give any reliable assurance of constant annual supply in specific quantity. In these circumstances industry would be faced with operating process plant for relatively short and unpredictable periods each year, a procedure with many inherent difficulties and one which would almost certainly be uneconomic.

Finally, not all forms of plankton are palatable or even nutritious, and some are toxic, presenting very serious problems in bulk harvesting when we have insufficient knowledge of the composition of the community.

Conclusion.

Each of the conditions enumerated above would militate against economic harvesting; but perhaps the most serious single factor would be the exceedingly low concentration of plankton, even in a "rich" area, which would limit the capacity of any harvesting system so far suggested and necessitate operating costs being kept at a level which it seems impossible to achieve. These are basic conditions and it is difficult to see how their adverse influence could be nullified by mechanical design.

It can only be concluded therefore that plankton harvesting could not be economically feasible unless and until areas of greatly increased population density can be either located or produced by artificial means, or a radically novel and cheaper method of harvesting becomes available.

References.

1. Clarke, G. L. (1939). "Plankton as a food source for man". Science, **89**, 602—603.
2. Hardy, A. C. (1941). "Plankton as a source of food". Nature, **147**, 695—696.
3. Juday, C. (1943). "The utilisation of aquatic food resources". Science, **97**, 456—458.
4. Lucas, C. E. (1951). "Four thousand million mouths". Oxford University Press.
5. Marr, J. W. S. (1938). "On the operation of large plankton nets". Discovery Rep., **18**, 105—120.
6. Tonolli, V. (1951). "Un nuovo apparecchio per la cattura di plancton in modo continuo e quantitative: il 'plancton-bar' ". Mem. Ist. Ital. Idrobiol., **6**, 193—202.
7. Shropshire, R. F. (1944). "Plankton harvesting". J. Mar. Res., **5**, 185—188.
8. Mackenzie, W. (1947). "Seaweed harvesting methods". The Engineer, **184**, 336—9, 373—5, 387—9.
9. Jackson, Philip (1952). "Harvesting of brown sublittoral seaweeds — Assessment of the problem and review of preliminary experiments". The Engineer, **193**, 718—720, 750—751.
10. Glenfield and Kennesy, Ltd., Kilmarnock, Scotland, 1953. "Microstraining plant for clarification of potable and industrial water supplies and effluents".
11. Hardy, A. C. (1941—42; 1942—43; 1943—44). "Plankton as Food". Scottish Mar. Biol. Assoc., Annual Reports.
12. Clarke, G. L., and Zinn, D. J. (1937). Biol. Bull., **73**, 464.
13. Confirmed by tests with the plankton sampler — Clarke (1, above).
14. Johnstone, J. (1908). "Conditions of life in the Sea". Cambridge.
15. Reay, G. A., Cutting, C. L., and Shewan, J. M. (1943). "The Nation's Food. VI. Fish as food. II. The chemical composition of fish". J. S. C. I., **62**, 77—85.
16. Harvey, H. W. (1950). "On the production of living matter in the sea off Plymouth". J. Mar. Biol. Assoc., **29**, 97—137.
17. Hardy, A. C., and Paton, W. N. (1947). "Experiments on the vertical migration of plankton animals". J. Mar. Biol. Assoc., **26**, 467—526.
18. Riley, A. G., and Gorgy, S. (1948). "Quantitative studies of summer plankton populations of the Western North Atlantic". J. Mar. Res., **7**, No. 2, 100—121.
19. Renow, J. (1949). "Methods of detecting fish by echo-ranging and echo-sounding". Proc. U. N. Scientific Conference on the Conservation and Utilisation of Resources, **7**, 95—96.
20. Hart, J. L. (1949). "Technological advances in fishing methods". Proc. U. N. Scientific Conference on the Conservation and Utilisation of Resources, **7**, 99.
21. Badger, W. L., and McCabe, W. L. (1936). "Elements of chemical engineering". McGraw Hill Book Co., N. Y.
22. Dickey, G. D., and Bryden, C. L. (1946). "Theory and practice of filtration". Reinhold Publishing Corporation, N. Y.

Utilisation d'une Laque pour l'Étude Morphologique des Poissons, notamment pour la Détermination de la Surface du Corps.

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Introduction.

La détermination de la surface du corps des organismes a toujours intéressé fortement certaines catégories de chercheurs, notamment les physiologistes. Dans son énumération des diverses méthodes appliquées à cette recherche pour les Vertébrés Benedict (1939) cite celle de Lee (1929) comme étant la plus exacte. Cette méthode consiste à plonger des Mammifères préalablement épilés dans une laque (laque commerciale de nitro-cellulose "Duco" et "Nitro-Valspar"). Quand cette laque est séchée, l'enveloppe qu'elle forme est enlevée, puis coupée en morceaux, qui sont mesurés. Comme cette méthode demande une peau parfaitement sèche, elle ne peut malheureusement pas être appliquée à la détermination de la surface des corps d'animaux aquatiques. Un rigoureux desséchement de la peau a pour conséquence des déformations importantes du corps[1]). En la laque "Cyclon" fabriquée par la maison Naegeli, Eschmann & Cie. S. A., à Zürich-Oerlikon, j'ai trouvé un produit, qui permet une application sur peau humide.

Cette méthode a été développée au cours de mes recherches sur la croissance relative de l'encéphale des Téléostéens. Avec elle, il m'a été possible de démontrer qu'il existe — au moins pendant l'ontogénèse post-juvénile — une relation linéaire entre le poids du cerveau et la surface du corps de la forme $y = ax + b$ (Geiger, *in litt.*).

Description de la méthode.

Le poisson frais ou conservé dans le formol est d'abord légèrement essuyé. Il est recommandé de mettre un peu de glycérine sur les nageoires, qui autrement sèchent trop vite de telle sorte que la couche de laque risque de rester collée. Après avoir attaché un fil dans la bouche du poisson, on plonge celui-ci un moment dans la laque assez épaisse.

[1]) Pendant la mise sous presse de cette communication a été publié un travail de H. Teichmann (Z. Morph. u. Oekol. Tiere, **43**. 1954). L'auteur enveloppe le poisson d'une simple couche de gaze et y applique du vernis zapon.

Ensuite on le fait égoutter et sécher dans une pièce bien aérée. La durée du séchage est à peu près de 4 à 6 heures. Des gouttes de laque, qui s'étaient durcies aux pointes des nageoires, disparaissent quand on les plonge dans le solvant "L", fabriqué par la même maison. Quand il s'agit de grands poissons, qui sont difficiles à plonger entièrement dans la laque, celle-ci peut être appliquée avec un pinceau sur la peau de l'animal.

Lorsque la couche de laque a séché, l'enveloppe est ouverte d'un coup de ciseaux le long de la ligne médio-ventrale et de la ligne médio-dorsale. Ensuite le poisson est soigneusement dépouillé. La laque, étant hydrofuge, ne s'attache pas à la peau; entre la couche de laque et la peau du poisson se trouve une autre couche ultramince d'eau ou de formol. Quelques incisions, pratiquées dans les deux moitiés du moule de laque, permettent d'étaler celles-ci à plat et ainsi de tracer leurs contours sur du papier calque, dont le poids par cm^2. est constant. Les deux surfaces de papier circonscrites sont découpées et pesées sur une balance de précision. Un calcul simple donne la surface du poisson en cm^2.

Les contours du moule applati peuvent être mesurés également à l'aide d'un planimètre.

Dans les deux cas l'erreur moyenne de la préparation et de la mensuration rest au-dessous de 1 %. La rétraction ultérieure de l'enveloppe vide monte à 0·7 % en moyenne, en dimension linéaire.

Autres applications de la méthode.

L'enveloppe de laque, en plus des dimensions de la surface du corps, donne une reproduction plastique, fidèle et durable de la structure de la peau et de la forme du corps du poisson. L'empreinte de laque est capable de fournir les mêmes indications numériques et méristiques que la surface de l'original. Par ce fait l'enveloppe de laque peut être considérée comme moyen de *documentation.* En outre elle possède, plus que la photographie ou le dessin, les avantages de l'original. Elle présente l'avantage supplémentaire d'être mesurable et surtout facile à transporter.

La laque "Cyclon" se laisse utiliser d'une manière excellente pour des *moulages d'organes en creux,* comme par exemple les fosses nasales. Dans ce cas la laque est appliquée avec une pipette aux parois de la cavité. Bien entendu, pour enlever la couche de laque séchée, on doit le plus souvent détériorer le poisson.

Enfin, l'enrobement complet du poisson dans une couche de laque sert de *gaine protectrice* contre l'évaporation. Un poisson fixé au formol et muni d'une enveloppe de "Cyclon" résiste à l'évaporation pendant au moins une semaine. On peut donc le transporter sans liquide ou emballage humide.

Bibliographie.

Lee, M. O., 1929. "Determination of the Surface Area of the White Rat with its Application to the Expression of Metabolic Results". Amer. J. Physiol., **89**.

Benedict, F. G., 1939. "Die Oberflächenbestimmung verschiedener Tiergattungen". Erg. Physiol., **36**.

Geiger, W. "Das Hirnwachstum der Knochenfische als Funktion des Wachstums ihrer Körperoberfläche". *In litt.*

Factors Affecting the Migration of the Silver Eel in Dutch Inland Waters.

By

C. L. Deelder.

AS is well known, every year in late summer and autumn, the silver eel migrates from fresh water to the sea. This provides an opportunity for numerous fishermen to catch large numbers of eels. The procedure usually followed in Dutch inland waters consists in completely barring the passage of the eels during the night by suspending a net across the canal. When the eel encounters this net, it starts searching for an opening and in so doing is very likely to fall into one of the many fish traps set on the bottom and sides of the canal. In these circumstances it may be taken that the catch is a measure of the intensity of migration. On Lake Yssel the procedure is the same, except that the place of the net is taken by the big "Afsluitsdijk" (i.e., "enclosing dike"), which similarly bars the passage of the silver eels.

Large fluctuations occur in the daily catches, and the present study is an attempt to find an explanation for them. The data for this statistical research were furnished by a number of fishermen who recorded the weights of their daily catches during the period 1947 to 1952 inclusive.

In the course of these investigations I have received much assistance, for which I should like to express my thanks. Mr. D. E. van Drimmelen and Ir. H. A. M. van Erp, Inspectors of Fisheries, took charge of the collection of the data; Dr. J. Veldkamp, Director of the 5th Department of the Royal Netherlands Meteorological Institute, De Bilt, provided me with the seismological information and was also good enough to read that part of the paper dealing with this subject; Prof. Hemelrijk and his staff assisted me with statistical analyses, and Dr. B. Havinga kindly read through my manuscript.

An idea of the intensity of migration in our inland waters can be obtained from the average values given in Table 1; these cover a period of about 5 years. It should be noticed that the end of the migration may be considerably delayed in some circumstances, e. g., by the onset of cold weather.

Table 1. Average catch of silver eels in Dutch canals by 5-day periods, from 1947 to 1952, expressed as percentages of the total catch.

5-Day period	Date	Catch %	5-Day period	Date	Catch %
1	10—14 VI	0·9	15	19—23 VIII	5·9
2	15—19 „	2·1	16	24—28 „	5·9
3	20—24 „	2·6	17	29—2 IX	5·8
4	25—29 „	2·7	18	3—7 „	5·1
5	30—4 VII	3·1	19	8—12 „	4·4
6	5—9 „	3·2	20	13—17 „	3·9
7	10—14 „	3·5	21	18—22 „	3·0
8	15—19 „	3·7	22	23—27 „	2·4
9	20—24 „	4·1	23	28—2 X	2·4
10	25—29 „	4·4	24	3—7 „	1·8
11	30—3 VIII	4·8	25	8—12 „	1·7
12	4—8 „	5·1	26	13—17 „	1·5
13	9—13 „	5·4	27	18—22 „	1·4
14	14—18 „	6·0	28	23—27 „	1·2

The investigations show that the large fluctuations in the catches are due to changes in the behaviour of the silver eels, in response to several factors. Three of these, namely, flow of water, phase of moon, and microseisms are probably stimulants to migration. In addition, the flow of water influences the direction of migration. It is not, of course, claimed that all the factors affecting the migration of silver eels are known. For instance, the reason why the height of migration intensity does not occur simultaneously in the inland canals and in Lake Yssel is still unknown. The collection of the data necessary for the solution of such problems is likely to require many more years, but it may be of interest to describe the results so far obtained. Some of our findings are not entirely new, but since they confirm the conclusions reached by other investigators, and for the sake of completeness, they are discussed in the present paper.

a. Water Flow.

According to the river fishermen, an increase in the stream is associated with an increase in the number of migrating eels. No data by which this opinion can be checked statistically have been obtained, but in view of the fishermen's very great experience of the matter, the association may be accepted as correct. It agrees, moreover, with the data given by Frost (1950), Jens (1952/53), and Lowe (1952).

Jens examined the relation between catch of silver eels and height of water in the Rhine, and reached the conclusion that most eels are caught when the water-level is highest. In my opinion, however, it is not so much the high water-level as the much increased flow which encourages the eel to migrate; this is also the opinion of Frost and Lowe. In this connexion it may be remarked that in Holland there are many "polders", low-lying areas enclosed by a dike, in which the water is kept at a constant level by water mills or pumps. As soon as these begin to pump water from the polder, the water in the polder canals starts to flow towards the mill. During the time a flow occurs, larger catches of silver eels are made, which suggests that the eels are stimulated into migration by the flow, since the water-level remains approximately the same or is even falling.

As has already been mentioned, the flow of water also seems to influence the direction of migration. In 1948 and 1949 we had the good fortune to obtain data on catches from a fisherman who fished a canal in which the water moved in alternate directions, at low speeds. Since he had placed his fish traps on both sides of his barrier net and had also recorded his catches for the two sets of traps separately, we were able to examine the effect of the stream on the direction of migration (Table 2), and it appeared that silver eels tend to migrate with the stream. We may expect this tendency to be the stronger the higher the rate of the stream. Consequently the fact that in rivers the silver eel moves only towards the sea and no silver eel has ever been seen swimming upstream may be ascribed to this inclination.

Table 2.

The relation between the direction of the flow of water and the direction of migration.

Direction of flow	1948	1949	Catches on the western side of the barrier net, expressed as percentages of the total catch.
eastward	56 %	55 %	
westward	27	16	
no flow	37	29	

b. Phase of Moon.

The influence of the moon is widely known. Frost (1950), Lowe (1952), Meyer (1938), and Nolte (1938) have already pointed to this effect in relation to the migration of silver eels in the Baltic and in English rivers, but their opinions were not based on statistical analyses. Quite recently Deelder (1953, cf. Table 3, A and B) and Jens (1952/53), independently of each other, undertook statistical studies of the migration of silver eels in stagnant inland waters in the Netherlands and in the Upper Rhine, respectively, while the latter also analysed Meyer's Baltic data. As a result of these investigations, it may be accepted that during migration the silver eel is influenced by the moon to a high degree. It is remarkable, however, that the effect does not appear to be felt everywhere at the same time. For instance,

in the Upper Rhine the height of migration occurs before the moon's last quarter (J e n s), while in the Baltic (J e n s) and in Dutch inland waters (D e e l d e r) it takes place after the last quarter. No explanation for this phenomenon can be found; perhaps the matter of sex enters into it, for in the Upper Rhine the eels caught are mainly females, whereas in other regions, certainly in the Dutch waters, males predominate.

According to J e n s, the moon's influence is not exerted through its light. He bases this opinion on the results of a study of the movements of silver eels on nights with clouded skies. Catches on these nights were classified according to phase of moon and averages computed, which cover a lunar period. Since they exhibit the lunar rhythm, he infers that the light of the moon has no effect.

Table 3. Relation between phase of moon and catch of eels.

A. In Dutch canals.

3-day period	a	b	c	d	e	f	g	h	i
Catch %[1])	10·4	10·0	6·3	7·5	12·7	16·1	14·8	11·3	10·7

B. In Lake Yssel.

7-day period	I	II	III	IV
Catch %[1])	21·2	18·9	29·8	30·0

In my opinion this deduction is unsound, for if an eel is subject to the influence of moonlight throughout its life, we may not assume that the affect does not assert itself when the sky is clouded and the moon invisible. Moreover, even when the sky is clouded, the light is still noticeable; with a new moon the night is always darker than with a full moon. It has been suggested that moonlight may set up an inner rhythm, which operates whether the light is present or not, as is the case with other animals (K o r r i n g a, 1947).

c. Microseisms.

When the daily catches in the canals are plotted in a graph, a remarkable phenomenon becomes evident; at intervals the catches rise sharply for a day or two and then quickly drop, so that the curve is very much serrated (Figures 1 and 2).

The Netherlands fishermen ascribe these sudden rises to weather conditions and connect them with the occurrence of storms. This opinion is also held in other countries. For instance, F r o s t (1950) and L o w e (1952) state that on stormy nights the eels in British rivers often migrate in large numbers. Twenty-eight cases of such distinct increases in catches occurred during the period 1947 to 1952 and they allow us to check

[1]) Calculated according to K e n d a l l' s method (K e n d a l l, 1948).

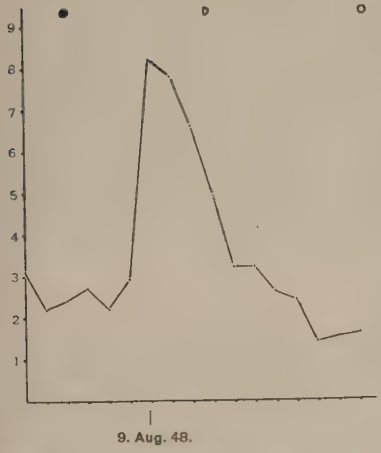

Figure 1. Showing a typical sudden rise in catch occurring on 9. August 1948.

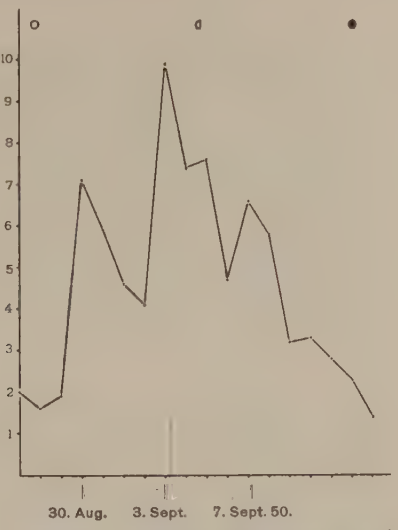

Figure 2. Showing sudden rises in catch on 30. August and 3. and 7. September 1950.

the extent to which weather conditions may be held responsible for this occurrence. We learn in the first place that in every case, without exception, the weather conditions over the Netherlands were governed by a depression present in the vicinity. Hence we infer that depressions influence eel migration; when they occur, many more eels migrate than usual.

Examination of the particular factors associated with a depression — for instance, strength and direction of the wind, air temperature and pressure, cloudiness, precipitation, etc. — fails to show any which might act as a stimulus to migration (Table 4). In the cases numbered 7, 14, 16, 22, 27, and 28 the weather conditions which prevailed are — in the opinion of the fisheries experts — in no way favourable to eel migration.

There is, however, one other factor which may provide the stimulus, viz., microseisms. These are vibrations of the ground and are frequently caused by depressions (cf. S c h o l t e, 1954). The vibrations may last for hours and in Holland have an amplitude of 1 to 20 microns. The amplitude depends on the intensity of the depression; the period, on the depth of the sea. Depressions over the Atlantic produce microseisms mainly of periods of 6 to 8 seconds; with those over the North Sea, the periods are shorter (Figure 3). In the western Atlantic there is in general a sharp division between the depths in the ocean itself (1000—4000 m.) and those on the Continental Shelf (100—200 m.), and accordingly the corresponding microseisms can be put into two fairly distinct groups. These vibrations are probably set up by the forces exerted on the sea-bottom by the high waves under the centre of the

Table 5. The weather conditions and microseismic periods in the 24 hours preceding the peaks in the catches of silver eels.

Case No.	Date	Increase of catch relative to previous catch	Wind direction[1])	Wind strength max. and average in m./sec.	Barometric pressure (millibars)[2])	Air temperature[3]) °C.	Precipitation[4])	Degree of cloudiness (0-10scale)[5])	Period of microseisms (sec.)
	1947								
1	10 VI	2·4	NW.	20/10	1013—1027	13	3	8	2·8
2	7 VIII	2·4	SW.	17/7	1006—1011	17	5	10	2·8
	8 VIII	2·4	NW.	13/7	1011—1017	16	1	8	2·6
3	10 IX	1·4	SW.	17/9	1012—1015	17	—	8	2·6
4	13 X	1·6	WSW.	27/13	1005—995	13	17	5	3
	1948								
5	6 VII	2·3	W.	13/6	1011—1022	14	—	10	3
	7 VII	1·3	SW.	12/6	1022—1019	13	—	9	3
6	22 VII	2·2	S.+W.	17/8	1015—1011—1017	20	—	5	3·1
7	25 VII	1·3	NE.	8/4	1020	15	—	7	3·3
	26 VII	1·3	NE.	6/3	1020	18	—	2	3·3
8	9 VIII	2·8	SW.	28/15	997—991—1000	18	4	8	3·1
9	24 VIII	1·9	SW.	15/7	1013	16	—	7	3
10	25 IX	2·4	SW.	12/5	1020	13	2	6	2·5
11	28 IX	1·6	SSW.	13/6	1013	18	—	1	2·9
12	23 X	3·7	SW.	27/13	1010—998	14	12	10	3·1
	1949								
13	5 VIII	1·3	W.	14/8	1010—1020	17	—	6	3·1
14	13 IX	1·6	E.	8/5	1021	19	—	3	2·7
15	18 X	4·3	SW.	17/8	1010—1015	13	2	5	3·1
	1950								
16	6 VII	2·1	W.+N.+E.	7/2	1012	17	18	10	2·5
17	11 VII	1·5	W.	15/8	1010—1013	17	—	7	2·7
18	25 VII	2·1	SW.	10/6	1017	17	1	5	2·9
19	5 VIII	1·4	NNW.	14/8	1007—1018	17	5	3	2·5
20	19 VIII	1·7	SSW.	10/5	1010—1020	14	—	7	2·5
21	30 VIII	3·9	SW.	18/9	1007—1018	17	8	8	3
22	3 IX	2·4	SE.+NW.	12/7	1013—1010—1013	13	6	8	2·5
23	7 IX	1·4	N.+SW.	20/13	1016—1003	15	—	6	3·3
	1951								
24	28 VIII	1·5	SW.	16/8	1006	14	2	7	2·7
25	16 XI	5	S.+SW.	15/9	1013—1011	8	3	10	3·2
26	25 XI	5	WSW.	24/13	998—1000—997	12	8	10	3·3
	1952								
27	5 VII	5·5	NE.	15/7	1025—1030	16	14	5	3·1
28	20 VIII	2	NE.	10/3	1004—1002	15	7	10	2·9
	21 VIII	1·4	N.	10/5	1002—1010	15	4	5	2·9

[1]) In the silver eel season the most frequent wind is south-westerly; the least frequent, easterly.

[2]) The average barometric pressure is about 1015 millibars.

[3]) The approximate average temperature of the air in June is ca. 15°C., in July and August 17°, in September 14°, in October 10°, and in November 5°C.

[4]) The average rate of precipitation is ca. 2·5 mm.

[5]) The average degree of cloudiness is ca. 7.

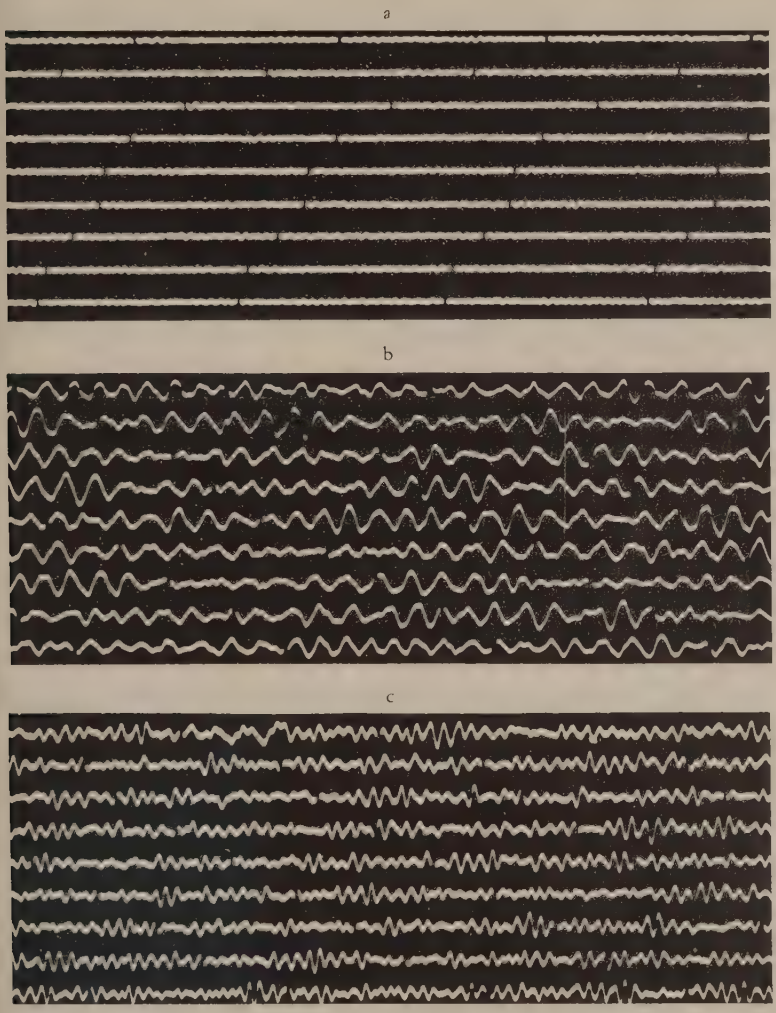

Figure 3. Vertical seismograms, registered on the Galitzin seismograph at De Bilt, Netherlands.

a) Day of microseismic calm 31. July—1. August 1953.
b) Microseisms caused by a depression over the Atlantic Ocean, 22.—23. December 1953.
c) Microseisms caused by a depression over the North Sea, 8.—9. August 1948.

The relation between actual and registered amplitudes is 1 : 725 for (b) and 1 : 575 for (c). 1 horizontal centimetre covers 20 seconds.

depression. From there they pass through the ground at a speed of several kilometres per second. The microseismic vibrations may be resolved into three components, two horizontal and one vertical.

Careful study of the data shows that the numbers of eels migrating rise sharply after the occurrence of microseisms with a period of about 3 seconds (Table 4). According to the weather charts, these appear to be caused by depressions centred over the North Sea or over the English Channel. Since all the notably large catches took place after the occurrence of microseisms with an approximately 3-second period, we are naturally inclined to think that the migration stimulus is provided by the microseisms, and this supposition is supported by the fact that 3-second microseisms have never occurred without being followed by a distinct increase in catches. This is the more remarkable, because it refers to a series of about 1000 fishing days.

Though our data clearly suggest the influence of microseisms, they do not constitute direct proof. This cannot be obtained until an aquarium study has been made of eels subjected to microseisms of various periods. In this connexion it may be mentioned that eels kept by L o w e (1952) in a laboratory in Westmorland showed considerably increased activity only on those nights on which the eels living under natural conditions also migrated in relatively large numbers. It is obvious that no weather conditions, except air pressure, could be held responsible for this coincidence. According to our observations, it is unlikely that air pressure activates the eels, while microseisms on the contrary evidently do. In these circumstances, the microseisms responsible would be those generated by depressions over seas with depths of about 100—200 m., for example, the Irish Sea.

As regards the mechanism by which the influence of microseisms is exerted, it may be noted that a relation exists between them and the pressure waves induced by them in the water. According to Dr. V e l d - k a m p, for a large lake, such as Lake Yssel, the relation is stated by the following formula:—

$$p = \varrho w^2 h u,$$

where p is the amplitude of the pressure waves in the water; ϱ, the density of the water; w, the frequency of the microseisms (2π/period); h, the depth of the water; and u, the vertical amplitude of the microseisms. Microseisms with a period of 4 seconds and an amplitude of 7 μ cause pressure fluctuations at the base of a 10 m. water column of the magnitude of 2 dynes/cm.^{2}, i.e., 0·002 millibar. These conditions, however, are not precisely applicable to canals, because in this case interference phenomena affect them to an extent depending on the circumstances.

Summary.

1) Records of their catches of silver eels have been kept by Dutch fishermen for several years. These data are used for a study of migration, which occurs annually between June and November.

2) One of the stimuli to migration in the silver eel appears to be the flow of the water, and the direction of flow determines the direction of migration; silver eels migrate with the flow.
3) The incidence of the migration urge appears to be closely connected with the phase of the moon. Most silver eels migrate by night at about the time of the last quarter.
4) The intensity of the migration of silver eels in Holland rises sharply under the weather conditions associated with the passage of depressions across seas in which the depth of water is about 100—200 m., e. g., the North Sea or the English Channel. It is highly probable that the microseisms generated by the depressions are responsible for this increased activity.

References.

Deelder, C. L., 1953. "Over de trek van de schieraal". Visserij Nieuws, **5** (11), pp. 124—125.

Frost, W. E., 1950. "The eel fisheries of the river Bann etc.". Journ. du Cons., **16** (3), pp. 358—383.

Jens, G., 1952/53. "Über den lunaren Rhythmus der Blankaalwanderung". Arch. f. Fischereiwiss., **4**, pp. 94—110.

Kendall, M. G., 1948. "Rank correlation methods". London.

Korringa, P., 1947. "Relations between the moon and periodicity in the breeding of marine animals". Ecol. Monographs, **17**, pp. 347—381.

Lowe, R. H., 1952. "The influence of light and other factors on the seaward migration of the silver eel (*A. anguilla* L.)". Journ. Anim. Ecol., **21** (2), pp. 275—309.

Meyer, P. F., 1938. "Die Beeinflussung des Blankaalfanges an der Rügenschen Küste durch meteorologische und kosmische Faktoren". Zeitschr. f. Fischerei, **36**, pp. 643—680.

Nolte, W., 1938. "Die Blankaalfischerei mit grossen Reusen an den Küsten Rügens". ibid., **36**, pp. 681—725.

Scholte, J. G. J., 1954. "Microseismen", in "Koninklijk Nederlands Meteorologisch Instituut 1854—1954". Den Haag.

The Destruction of Oyster Spat by *Urosalpinx cinerea* (Say) on Essex Oyster Beds.

By

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Introduction.

The American whelk tingle, drill or borer, *Urosalpinx cinerea* (Say), was first recorded in this country on the oyster beds of the river Blackwater, Essex, by Orton and Winckworth (1928). Orton (1930) subsequently discovered specimens among material collected in 1920.

In America, *Urosalpinx* occurs in very large numbers from Cape Cod to Florida, and was carried more recently with oysters to San Francisco. Walters (1910) obtained 2,000 *Urosalpinx* from one boulder in New England. Galtsoff, Prytherch, and Engle (1937) caught over nineteen thousand *Urosalpinx* in nine hours, using a drill dredge, and forty-five thousand in three months, using traps. These figures indicate the enormity of the problem there, and it is not surprising that the estimate of the annual damage caused by drills amounts to several million dollars.

Urosalpinx was probably brought to this country with consignments of American Atlantic oysters (*Gryphaea virginica*) which were relaid regularly at Brightlingsea and West Mersea up to the outbreak of World War II. It now occurs abundantly in the rivers Blackwater and Colne. Cole (1942) suggests that *Urosalpinx* was introduced more recently into the Roach—Crouch river-system from West Mersea, probably not long before 1934. He recorded it as occurring sparingly in the river Crouch, and more abundantly in the river Roach. During the period of twenty years since its introduction into the rivers Crouch and Roach, *Urosalpinx* has spread and multiplied and, aided by the cold winters of 1929 and 1939 (Orton and Lewis, 1931; Cole, 1942), has entirely replaced the native rough tingle, *Ocenebra erinacea*.

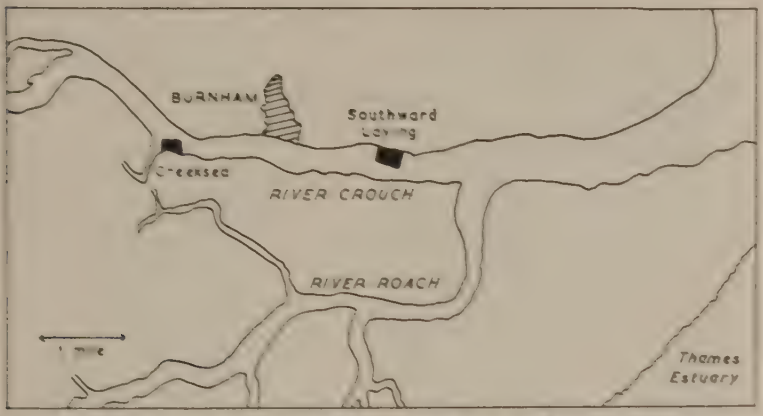

Figure 1. Map of rivers Crouch and Roach at H. W. N. T. showing the oyster grounds referred to in the text (▬).

Mistakidis (1951) found a maximum density of 6 *Urosalpinx* per square metre on the Southward Laying (see Figure 1) in the river Crouch in 1948, and an average of 2—3 oysters per square metre. By 1952 the number of oysters on the Southward Laying had increased by six times, largely as the result of relaying, and a further survey by the writer revealed a maximum density of 11 *Urosalpinx* per square metre, corresponding in position with the maximum density of oysters.

Urosalpinx feeds by attacking other shellfish, using its radula to drill a neat circular hole through the shell of its prey. It inserts its proboscis through the hole, and the flesh of the prey is rasped away by the radula and devoured. Carriker (1943), in his very comprehensive paper, observed that penetration of the shell is facilitated by a "softening agent", which may be considered as a chemical supplement to the radula.

It has been observed that *Urosalpinx* will feed on a variety of molluscs including *Ostrea edulis* and its spat, *Mytilus edulis*, *Cardium*, *Paphia* spp., the American slipper limpet *Crepidula fornicata*, and the barnacles *Balanus* spp. and *Elminius modestus* (see Figure 2). Galtsoff, Prytherch, and Engle (1937) showed that in the United States oyster drills preferred barnacles over all other food animals studied, possibly owing to the accessibility and lack of protection of the edible parts. It is possible that *Urosalpinx* has undergone some change in its food preferences since its introduction into this country, for drilled oyster spat are frequently found on shells which are covered with live barnacles, and tingles have been observed drilling young oysters, mussels, and even Crepidula, which were coated with barnacles. However, on examination, a high proportion of the barnacles were found to be *Elminius*, which has only very recently appeared and established itself as the dominant barnacle in the Essex rivers (Knight-Jones, 1948). Juvenile tingles have, however, been observed feeding

Figure 2. Molluscs drilled and eaten by *Urosalpinx*.
A. *Crepidula fornicata*. B. *Cardium edule*.
C. *Mytilus edulis*. D. *Paphia aurea*. E. *Ostrea edulis*.

on *Elminius*, which may be drilled either through the operculum, or one of the fixed plates (see Figure 3), in which case little advantage is obtained from the accessibilty of the prey.

There has been considerable speculation regarding the amount of damage caused to oysters and their spat by *Urosalpinx*, but there is very little precise information. Orton (1937) claimed that *Urosalpinx* had devoured 50 % of a spatfall on oyster beds in the river Blackwater, but offered no supporting evidence. Nelson (1922) found that in Delaware Bay, U. S. A., 33 % of the spat from one oyster bed, 41 % from another, and 50 % from a third had been drilled.

There have been heavy mortalities among oyster spat settled in the rivers Roach and Crouch in recent years. Knight-Jones (1952) records that in 1947—1949 counts of spat on shells indicated a high mortality during the first month after settling, about 50 % during the second month, and over 50 % during the following winter. He lists the attacks of *Urosalpinx* as prominent among the dangers to which spat are exposed. It was decided that an investigation of the proportion of this mortality attributable to *Urosalpinx* would provide useful information relating to the problem of preservation of oyster spat.

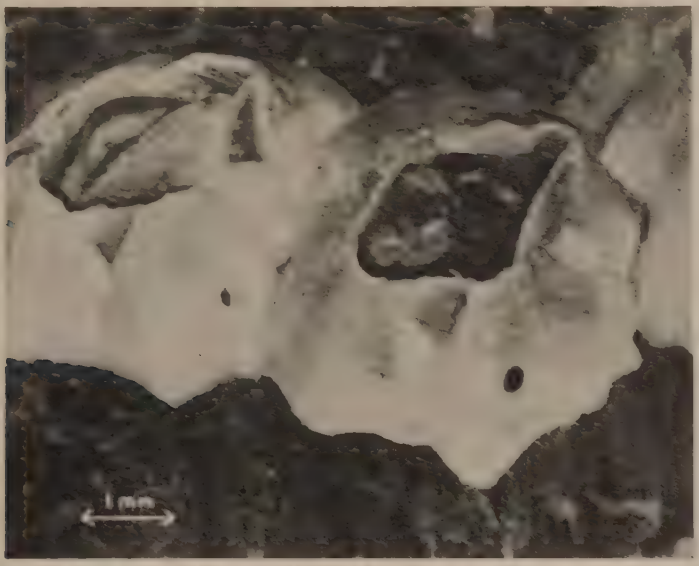

Figure 3. The barnacle *Elminius* drilled by a young *Urosalpinx*

Figure 4. Juvenile *Urosalpinx* which has drilled a young oyster spat

Observations.

In 1953 a fairly good spatfall was recorded on the Southward Laying. It was decided that this offered a suitable opportunity for measuring the quantity of oyster spat destroyed by tingles.

Juvenile tingles, as soon as they emerge from their egg capsules, are able to drill oyster spat and barnacles. Young tingles 2—3 mm. long have been noted feeding in aquarium tanks on oyster spat 4—5 mm. in diameter (see Figure 4), and on barnacles (see Figure 3). The holes produced were between only 0·08 and 0·18 mm. in diameter. It is evident that a great deal of destruction of oyster spat is overlooked by the oystermen, when the only indication is holes as small as these. Juvenile tingles began to emerge from their capsules early in July 1953, when the first spat to settle in the season were only a few weeks old.

The destruction of newly settled spat by tingles of any age would be an impractical observation in the field, because the tiny valves are quickly lost, leaving no traces. It was decided to concentrate only on easily visible spat, which, after drilling, would still be represented by the attached valves, even if the drilled free valves were missing. The flat valve is attached to the substrate, which is usually the shells in the cultch, but may often be the surfaces of live oysters and other shellfish. Thus only spat of 4—5 mm. diameter, and larger, were considered as

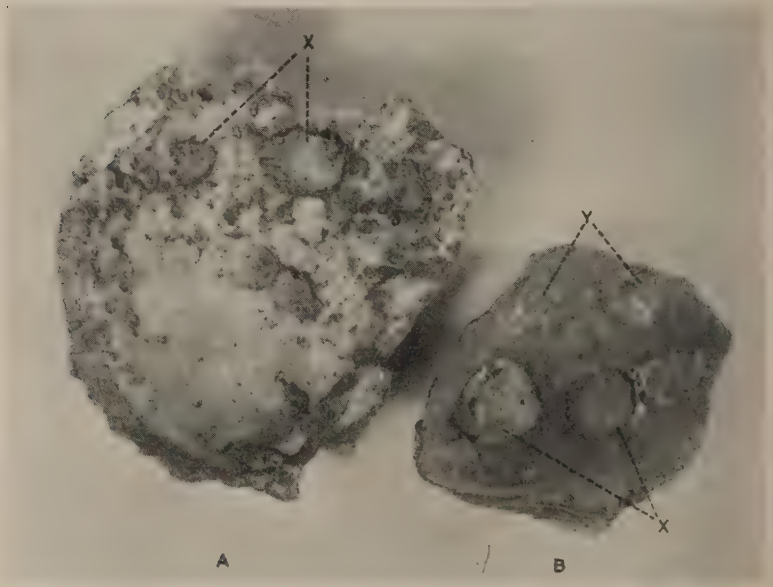

Figure 5. A. Oyster shell bearing live barnacles, and oyster spat drilled by *Urosalpinx*. B. Drilled oyster spat with (X) two valves, (Y) only one valve present.

being certain of detection when drilled, or most likely to leave a trace if the upper valve was lost (see Figure 5).

To estimate the destruction of spat by *Urosalpinx*, dredge hauls were made every few weeks between August and December 1953 on the Southward Laying, and the spat on 50 randomly selected pairs of oyster shells counted as live or dead. The dead spat fell into two categories according to whether one, or both, of the valves were retained. If there were two valves representing a dead spat, the presence or absence of a drill hole was noted.

Table I. Oyster Spat counted from 50 randomly selected pairs of Oyster Shells dredged from the Southward Laying, River Crouch.

All figures expressed as percentages.

Date	Live spat	Drilled spat	Spat dead from other causes	Only one valve remaining	Total mortality	Mortality by Urosalpinx	Mortality from other causes
22. Aug.	70·4	19·1	3·6	6·9	29·6	24·9	4·7
7. Sept.	67·2	24·0	2·0	6·8	32·8	30·2	2·6
24. Sept.	62·4	19·7	1·1	16·8	37·6	35·4	2·2
27. Oct.	43·3	15·2	5·2	36·3	56·7	45·5	11·2
18. Nov.	27·5	19·2	4·4	48·9	72·5	58·6	13·9
22. Dec.	26·8	10·6	3·8	58·8	73·2	57·4	15·8

In the first sample, the spat in which only one valve remained were divided in the same proportions as the drilled spat and spat dead from other causes. In subsequent samples the percentage of spat in which only one valve remained increased, owing to weakening of the hinge and loss of some further valves as a result of water movements. Since the intensity of feeding by *Urosalpinx* is not a constant, it would be inaccurate to apportion the spat represented by only one valve in the same manner as for the first sample, without taking into account the results from previous samples. For this reason, only the increase over the previous sample in the percentage of spat with one valve was divided in the same manner as for the first sample. The remainder was divided according to the final proportions of mortality by *Urosalpinx* and mortality from other causes determined from the previous sample.

It can be seen from the results in Table I that 58 % of the easily visible spat on the Southward Laying had been destroyed by *Urosalpinx* before the drills ceased feeding early in November. The total mortality of oyster spat at this time was 72·5 %.

It must be remembered that these figures represent the mortality of only readily visible spat, and that even this must be only a minimum. Live spat are always more easily visible than single valves, which are also liable to overgrowth by encrusting organisms. This destruction of spat took place on a ground where there are adequate supplies of other food, including barnacles in profusion, large numbers of *Crepidula*, the drilled shells of which are sometimes found on the oyster laying, and other shellfish.

At Creeksea, two-and-a-half miles up the river Crouch from the Southward Laying (see Figure 1), a total mortality of 66 % was recorded in December, and from the results of previous periodical observations similar to those made on the Southward Laying, it was deduced that 55 % of the easily visible spat had been destroyed by *Urosalpinx*.

After a period of winter inactivity, feeding usually begins when the water temperature reaches 9—10°C. In August, about 3 months after feeding commenced, it was found, during a survey of mortality among oysters, that on the Creeksea Laying at least 10 % of the brood oysters had been drilled, together with more than 5 % of oysters larger than brood size (in this case larger than about 60 mm. average diameter). This should be compared with the figures of only 2—3 % for other oyster layings in the rivers Roach and Crouch. It was nearly 3 months after this survey that the water temperatures dropped below 10°C. and feeding ceased, but a further observation on this mortality was not possible owing to large-scale removal of oysters from the ground. It is probable that the attention of at least some of the *Urosalpinx* was subsequently diverted from the brood oysters by the appearance of rapidly growing oyster spat, which is evidently the favourite food of the tingle in these rivers.

The oysters destroyed at Creeksea were all at least three years old. They were not the spat which settled in 1952, and there was virtually no spatfall in 1951, so it was concluded that they had grown from spat which had settled in 1950 or earlier. The number destroyed in the area under cultivation (approximately 20,000 square metres) was calculated to be 25,000 brood and 1,200 adult oysters. This high predation on larger oysters may be due to the very small quantity of spat settling on this ground during the past two years, coupled with the fact that at Creeksea there is only a small settlement of barnacles, on which Urosalpinx will feed when oyster spat is not readily obtainable. On the Southward Laying the destruction of oysters larger than spat was quite small, but there the settlement of barnacles is always very heavy.

After the percentage of spat destroyed by *Urosalpinx* had been determined, it was decided that it would be useful to obtain an estimate of the actual number of spat present on the Southward Laying. This was calculated from the results of a short survey using a Van Veen bottom sampler. Half the cultivated oyster ground on the Southward Laying was marked out into four sectors, and ten grab hauls were made in each sector. The grab removed $^1/_{10}$ square metre, so that the number of organisms in ten hauls represents the density per square metre. The numbers of live and dead spat were counted in the same way as for the dredged oyster shells, and the numbers of *Urosalpinx* noted. The results are represented in Figure 6.

The original dredge hauls, from which the spat settled on oyster shells were counted, were made at a point intermediate between the inshore and offshore stations. The average of the total mortalities of spat at the four stations in Figure 6 was 72·8 %, and is in very close agreement with the figure of 73·2 % for mortality of easily visible spat determined by the examination of oyster shells. It can therefore

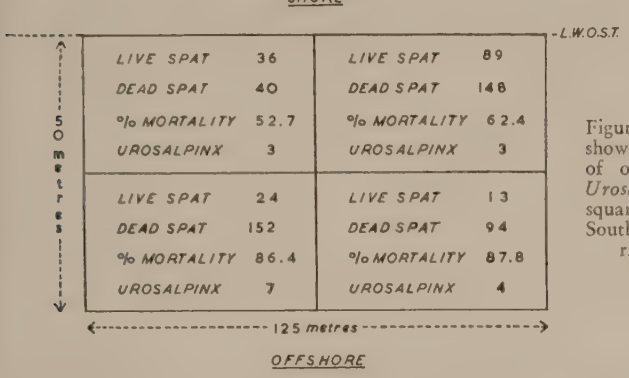

Figure 6. Diagram showing the numbers of oyster spat and *Urosalpinx* per square metre on the Southward Laying, river Crouch.

be assumed from the previous figures that 58 % of the total spat were destroyed by *Urosalpinx*. The total spat, live and dead, from the four stations was calculated to be 931,000, so that it is estimated that 540,000 oyster spat were destroyed by *Urosalpinx* in an area of only 6,250 square metres of oyster ground.

This can be seen to give, as an average, the figure of 86 oyster spat per square metre of cultivated oyster ground on the Southward Laying destroyed by *Urosalpinx*. This represents 20 oyster spat per tingle during the season.

Discussion.

A number of experiments designed to determine the rate of feeding of *Urosalpinx* under experimental conditions have been described. Cole (1942), by enclosing known numbers of tingles in wooden wire-covered floating cages in outside concrete tanks, showed that one *Urosalpinx* feeding exclusively on one-year-old oyster spat would destroy 59 in a season. This figure was based on a season lasting five months. In the present field observations the feeding period was limited anteriorly by the first settlement of spat at the end of June. This spat was several weeks old before it had grown sufficiently to be counted at a diameter of 4—5 mm. Consequently, the period during which *Urosalpinx* fed on the 1953 spat had been restricted to a little over three months by the time the water temperature in the river had dropped below 9—10°C., early in November. The figure obtained for the Southward Laying, of 20 spat destroyed by *Urosalpinx* during the season, is lower than that determined by Cole. However, for reasons previously mentioned it represents a minimum estimate. The smallest spat drilled have not been represented and *Urosalpinx* is not restricted to oyster spat in its diet, but also feeds at a much slower rate on older oysters and other shellfish.

Experiments conducted by Cole (unpublished), in which *Ocenebra* were confined with one-year-old oyster spat under similar conditions

to those in his previous experiments with *Urosalpinx*, showed that in the same period *Urosalpinx* consumed three times as many spat as *Ocenebra*. This seems to indicate that *Ocenebra* either consumes oyster spat with some reluctance, or that its natural voracity is less than that of *Urosalpinx*.

It has been stated that only easily visible spat were included in this estimate, and that 58 % of these were destroyed by *Urosalpinx*. The destruction of newly settled spat by juvenile tingles has been recorded, but would be an impractical observation in the field. Cole (1942), however, has estimated from laboratory experiments that juvenile tingles are capable of destroying as many as 100 newly settled spat each, during the period July to September inclusive. Bearing this figure in mind, and remembering that *Urosalpinx* will resume its attack on any remaining spat when the temperature rises above 9—10°C. in 1954, we may agree with Cole (1951) when he says that in the Essex rivers 75 % would probably not be an overestimate of the percentage of spat destroyed by *Urosalpinx* during the first year of its life. It may be thought that the unusually mild weather conditions prevailing at the onset of the winter in 1953 had served to extend the feeding period of *Urosalpinx*, and that, in consequence, the number of drilled spat was abnormally high. Although the air temperatures during November and December were higher than in previous years, the water temperature on the river bottom fell to, and remained below, the 9—10°C. required for feeding by *Urosalpinx*, from about the same date as in the previous year. It is unlikely therefore that the number of spat drilled in 1953 was unusually high, owing to extended favourable water temperatures.

It may be concluded from the observations made at Creeksea that the damage caused by *Urosalpinx* to oysters of three years of age, and more, may be of more consequence than expected by Cole (1951), who states that although *Urosalpinx* will on occasion attack adult oysters, it is a serious pest only of spat and brood oysters up to two years of age.

It has been established that the feeding activities of *Urosalpinx* cause a heavy mortality among developing oyster spat. The question remains to be answered whether large-scale removal of *Urosalpinx* will, in fact, allow an increased survival of oyster spat. It has been stated that *Urosalpinx* feeds also on other shellfish, including barnacles and slipper limpets, which are important competitors of the oyster. If barnacles were to form the most important ingredient in the diet of *Urosalpinx*, the removal of the latter might allow an increase in barnacle settlement, thus reducing the amount of food and area of settlement available for oyster spat. It has, however, been shown that oyster spat is devoured in preference to *Elminius*, which is the dominant barnacle on the Southward Laying. *Mytilus edulis* is virtually absent from the Southward Laying (Mistakidis, 1951, and own observation) and neither *Cardium edule* nor *Paphia aurea* are present . The remaining observed food of *Urosalpinx* is *Crepidula fornicata*, enormous numbers of which compete severely with the oysters for food on the Southward Laying

and nearly all the Essex oyster beds. The largest numbers of *Crepidula* occur further offshore than the oysters and their spat, and the natural population of *Urosalpinx*. This is partly due to a difference in natural distribution, and partly to the effects of cultivation during which *Crepidula* is removed from, and oysters relaid in, the area immediately below low water of ordinary spring tides. *Urosalpinx* is abundant on the shore during the breeding season, an unnatural position for *Crepidula*, and is normally concentrated among the highest numbers of oysters and their spat. An investigation of dead *Crepidula* shells from the Southward Laying shows that *Crepidula* spat are rarely drilled, while only 3 % of the shells larger than spat size showed drill holes. It can be concluded that the predations of *Urosalpinx* cause such a small percentage of the mortality of *Crepidula* as to have a negligible effect on its population.

Urosalpinx presents a severe problem to the native oyster industry, which is so dependent on good spatfalls to maintain its existence. It is fortunate that oyster spat settles also on beds higher up the river, to which *Urosalpinx* rarely penetrates, in consequence of lower salinities, but there other conditions are less favourable for survival of oyster spat (Knight-Jones, 1952).

Investigations have shown that *Urosalpinx* has not spread very far by its own activities. Unlike *Crepidula*, it has no free-swimming stage in its life history, and its eggs develop and fully formed young tingles emerge from the egg capsules. Any marked dispersal has been a result of the relaying of oysters carrying tingles or their spawn on other oyster grounds outside the normal area of distribution of *Urosalpinx*. In this way *Urosalpinx* has been transported from the east coast of America to San Francisco Bay (Galtsoff, Prytherch, and Engle, 1937) and from the United States to Great Britain. From the rivers Blackwater and Colne it was taken to the rivers Roach and Crouch, and then to the Whitstable Flats in Kent. It is essential that oysters should not be transferred from an area where *Urosalpinx* is known to exist to others at present free. Even the most careful inspection may fail to reveal the spawn or young of this pest, which may be concealed within crevices on the shell.

Meanwhile, until efficient methods of control are devised, all *Urosalpinx* and their spawn should be systematically removed during normal dredging, and when handpicking on the shore, and destroyed. Efforts in this direction will be more than compensated by the increased survival among oysters and their spat.

Summary.

A short account of the feeding habits of *Urosalpinx* is given.

Observations on easily visible oyster spat showed that 73 % of the spat which settled in the summer of 1953 on the Southward Laying, river Crouch, were dead by December. 58 % of the spat had been destroyed by *Urosalpinx*.

On another laying in the river Crouch 55 % of the easily visible

spat was destroyed by *Urosalpinx* in the same period. 10 % of the oysters of 3 years and older had been destroyed half way through the season.

A grab survey at the Southward Laying confirmed the figure of 73 % for total mortality of easily visible oyster spat. It was calculated that 86 oyster spat per square metre were destroyed by *Urosalpinx*. This represents 20 oyster spat per tingle during the season.

References.

Carriker, M. R., 1943. "On the structure and function of the proboscis in the common oyster drill, *Urosalpinx cinerea* Say". J. Morph., **73**, 3, 441—506.

Cole, H. A., 1942. "The American whelk tingle, *Urosalpinx cinerea* (Say), on British oyster beds". Journ. Mar. Biol. Assoc. U. K., **25**, 477—508.

Cole, H. A., 1951. "The British oyster industry and its problems". Cons. Internat. Explor. Mer, Rapp. et Proc.-Verb., **128**, 7—17.

Galtsoff, P., Prytherch, H. F., & Engle, J. B., 1937. "Natural history and methods of controlling the common oyster drills (*Urosalpinx cinerea* Say and *Eupleura caudata* Say)". U. S. Bur. Fish., Fish. Circ., 25, 1—24.

Knight-Jones, E. W., 1948. "*Elminius modestus:* another imported pest of east coast oyster beds". Nature, **161**, 201—2.

Knight-Jones, E. W., 1952. "Reproduction of oysters in the rivers Crouch and Roach, Essex, during 1947, 1948, and 1949". Min. Agric. Fish., Fish. Invest., Ser. 2, **18**, 2.

Mistakidis, M. N., 1951. "Quantitative studies of the bottom fauna of Essex oyster grounds". Min. Agric. Fish., Fish. Invest., Ser. 2, **17**, 6.

Nelson, T. C., 1923. "Investigations of the oyster drills, *Urosalpinx* and *Eupleura*." Rep. N. J. Agric. Exp. Stat. 1922, 334—335.

Orton, J. H., 1930. "On the oyster drills in the Essex estuaries". Essex Nat., **22**, 298—306.

Orton, J. H., 1937. "Oyster Biology and Oyster Culture". London.

Orton, J. H., & Lewis, H. M., 1931. "On the effect of the severe winter of 1928—29 on the oyster drills of the Blackwater estuary". Journ. Mar. Biol. Assoc. U. K., **17**, 301—13.

Orton, J. H., & Winckworth, R., 1928. "The occurrence of the American oyster pest *Urosalpinx cinerea* (Say) on English oyster beds". Nature, **72**, 241.

Walters, H. E., 1910. "Variations in *Urosalpinx*". Amer. Nat., **46**, 577.

The Use of Neutral Red Solution for the Comparative Study of Filtration Rates of Lamellibranchs.

By

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Introduction.

Several methods have been described (Galtsoff, 1926, 1928; Nelson, 1936; Fox, Sverdrup, and Cunningham, 1937; Loosanoff and Engle, 1947; Jørgensen, 1949) for estimating the amount of sea water pumped by lamellibranchs, but where a simple comparison is required these methods have various drawbacks. The techniques suggested by Galtsoff (1928), and since used by many workers, have the disadvantage that they need rather complicated apparatus and careful preparation of the material. The method used by Jørgensen (1949) relies upon the mussels secreting mucus, as observed by MacGinitie (1941).

The technique here described was originally evolved by the senior author for the study of variations in filtration rates of mussels (*Mytilus edulis*) at different temperatures and salinities. It has since been used to assess the effect of parasitization by *Mytilicola intestinalis* on the rate of passage of water through the gills of mussels. The technique is simple to use and needs very little apparatus, and seems to have a wide application. It is capable of giving very consistent results, and is therefore reliable for comparative work.

Neutral Red in solution in sea water is absorbed and retained by the gills of lamellibranchs. It acts as an intra-vitam stain and the amount removed from the water seems to depend directly upon the volume of water pumped through the gills, regardless of whether or not mucus is secreted. Mussels appear to be unaffected by Neutral Red even after a week in a solution much stronger than that used in the experiments.

No attempt will be made here to describe how the technique could be used for absolute measurements of water volumes passing through

the gills, but it is not considered that such a modification would present serious difficulties. Such absolute measurements have in general less value than comparative studies of the effect of varying environmental conditions.

Other intra-vitam dyes have been tried, including Methylene Blue, Dahlia Violet, Janus Black, Trypan Blue, Isamine Blue, Janus Green, and New Red, but the only one of value was New Red; this, however, was less effective than Neutral Red.

Technique.

The mussels or other molluscs to be tested are placed in a 0·001 % solution of Neutral Red in sea water, allowing about 1 litre of water per mussel (*M. edulis*) of medium size (ca. 7·5 cm.). Mussels may be

Figure 1. Front and back views of the apparatus used for colorimetric comparisons. Illumination was provided by a white horizontal strip light, with a shield, not shown in the photograph.

tested singly or in batches. At intervals of 15—30 minutes 100 ml. of the solution are removed with a pipette to a graduated Heyner cylinder (Figure 1) and acidified with 10—20 drops of 5 % HCl. Neutral Red, besides being an intra-vitam dye, acts as an indicator with an approximate range of pH 6·5 to 8·0. At the acid end of the range it is a good pink, very suitable for colorimetric comparisons. Acidification beyond the limits set must be avoided, as it leads to decolorization. To provide a standard, 100 ml. of the original (0·001 %) solution is placed in a second Heyner cylinder. The two cylinders are held side by side over

evenly illuminated white ground, shielded from direct light, and standard is run off until, when viewed from above, the colours of solutions in the cylinder match. The amount of liquid (in ml.) left he standard equals the percentage Neutral Red not removed by the lusc̄s under test and hence, by subtraction from 100, gives the entage removed. The comparison of colours is made easier if, re possible, the sea water is first filtered. Care should be taken not disturb the mussels when withdrawing solution. All experiments ld be set up in uniform vessels and on a firm bench not subject to ations.

It may be found that the readings for the first 15 minutes are some- t erratic, owing to delays of varying length before the mussels open begin filtering. It is often convenient to ignore this period and to n recording at the end of 15 minutes, regarding the concentration Neutral Red remaining as the standard.

Examples.

Variation of filtration rates of mussels with temperature.

The experiments here recorded were made in the winter 1934—35. n experiment comprised three or four batches of six mussels of orm type and size, each contained in 15 l. of sea water in a shallow l. The salinity was 24·5 ± 0·5 ‰. All mussels used were kept out vater for 24 hours before an experiment was begun. The water used allowed to settle overnight. The percentage of Neutral Red removed estimated at 1, 2, and 3 hours after the commencement of the eriment. Water temperature was recorded at the outset and at hourly rvals; it did not vary by more than 0·5°C. during the course of an eriment (3 hours). The mean percentage of Neutral Red removed calculated for the 4 batches and the results are plotted in Figure 2. a few experiments the water was slightly warmed artificially but rwise the temperatures were those occurring naturally in a covered lated building. Experiments were begun in November and continued l the following February. At this time of the year the flesh condi- of mussels at Conway varies but slightly; spawning does not mence until March.

t is of interest to compare Figure 2 with that given by G r a y (1928) the effect of temperature on the rate of beat of frontal cilia from gills of *Mytilus edulis*. There is a striking degree of conformity, irming the reliability of the Neutral Red technique. Subsequent k at Conway (A l l e n *et alii*, 1950) has confirmed the marked ction in filtration rate which occurs below 5°C.

Variation of filtration rates of mussels with salinity.

These experiments were also made in the winter of 1934—35. hes of 6 mussels of uniform size and type were again used, each h being placed in 15 l. of water. The experiments were set up in an lated building where the temperature variation during the period

of an experiment was negligible. The requisite range of salinity was produced by adding varying amounts of tap water to sea water taken from the estuary at high tide. Experiments were allowed to continue for 4 to 8 hours. A typical result is shown in Figure 3. It appears that low salinity has a much greater depressing effect upon the rate of filtration in mussels than has been generally realized (D o d g s o n, 1928).

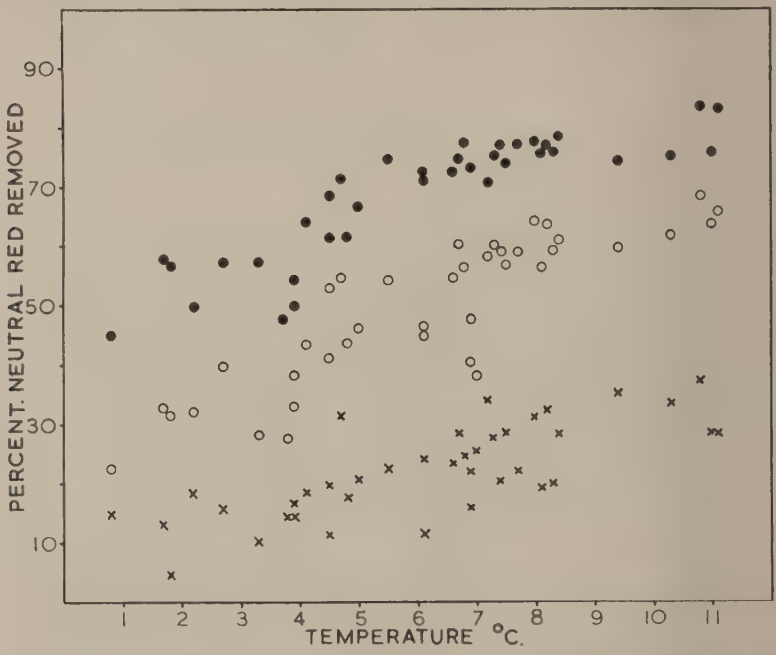

Figure 2. The effect of water temperature upon the filtration rate of mussels. Percentage Neutral Red removed shown as follows:— × after 1 hr.; O after 2 hrs.; ● after 3 hrs.

The mussels used in this trial were from the lower, more saline reaches of the Conway estuary and would not be subject, except during prolonged wet spells, to water of greatly reduced salinity. It is probable that mussels more frequently and regularly exposed to low salinities would differ in their behaviour. It is well known that mussels may become habituated to conditions of reduced salinity.

(c) Effect of parasitization by *Mytilicola intestinalis* on filtration rate in mussels.

M e y e r and M a n n (1950) state that the filtration rate of *Mytilus edulis* is reduced when it is parasitized by *Mytilicola intestinalis*, Steuer. If this is so, and if parasitized mussels ever come on to the market in

Britain, it may be necessary to modify the cleansing technique in use in Britain (D o d g s o n, 1928). Several series of experiments were therefore set up to determine the reduction, if any, in filtration rate of parasitized mussels. The result of one such series is recorded here.

Single mussels (length 5·8—6·5 cm.) were placed in 1 l. of 0·0004 % Neutral Red in sea water, and the percentage Neutral Red removed was estimated at 15-minute intervals. At the end of the experiment the mussel was dissected and its parasites counted. The mussels were then grouped according to the number of parasites which they contained (0,

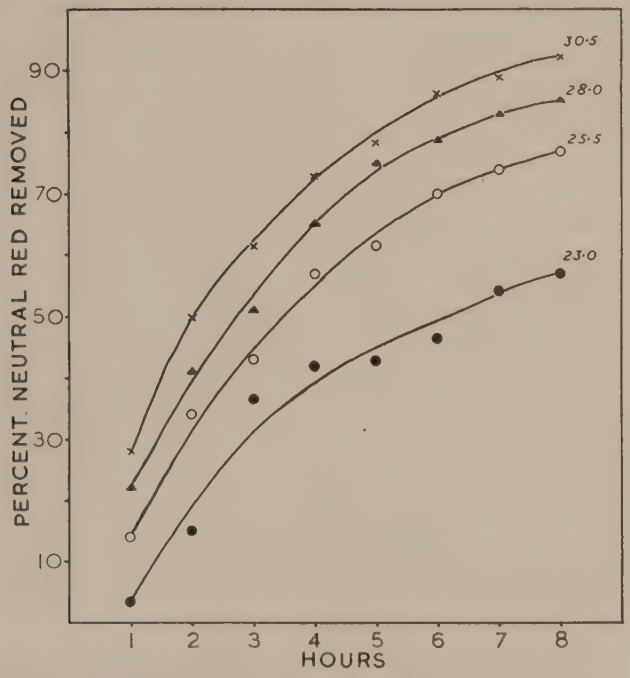

Figure 3. The effect of salinity upon the filtration rate of mussels. Salinity is shown by the figures on the right of the curves.

1—10, 11—20, and 21—30 parasites). The means of the results from each group are plotted in Figure 3.

It would appear that the filtration rate of mussels is not appreciably affected by the presence of *Mytilicola*, and no modification of the D o d g s o n cleansing technique appears necessary to deal with parasitized mussels.

Application.

The Neutral Red technique of comparing filtration rates of filter-feeding molluscs may be used to assess the effect of a great variety of

environmental conditions, including salinity, temperature, pH, turbidity, light, and concentration of food organisms. It is likely to be very useful also in the examination of polluted waters suspected of containing harmful substances. Such toxic effluents may reduce both filtration rates (Galtsoff *et alii*, 1947) and the period during which the molluscs remain open and pass a current. The effect of intrinsically inert polluting substances, such as china clay, which may remain in suspension for long periods, may also be examined.

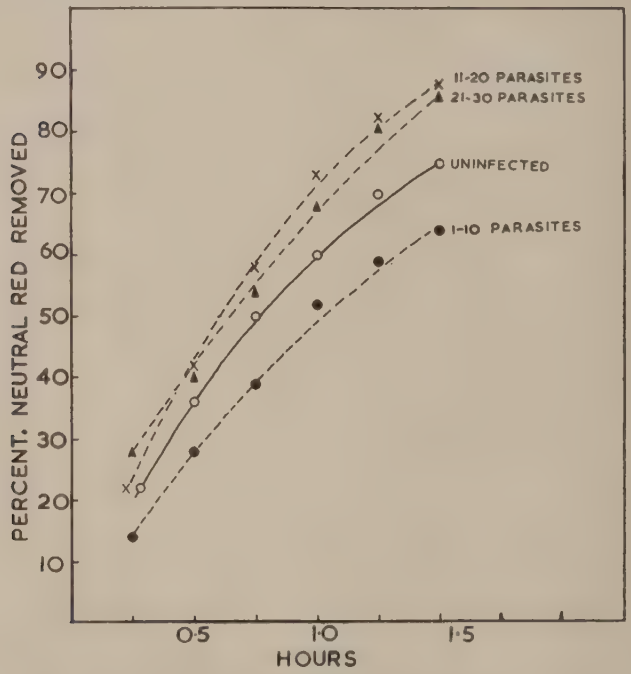

Figure 4. The effect of parasitization with *Mytilicola intestinalis* on the rate of filtration by mussels.

The value of Neutral Red in assessing the results of parasitization by *Mytilicola* has been illustrated above. It has been observed also in these experiments that in mussels the presence of larval trematodes and the pea crab *Pinnotheres* may influence filtration rates, and the changes resulting can be measured by this technique.

It has been found also that by the use of Neutral Red convincing demonstrations of the role of the gills in feeding may be set up and these have their value in teaching. *Paphia pullastra*, *Ostrea edulis*, *Gryphaea angulata*, and *Cardium edule* also remove Neutral Red from sea water but no measurements have been made with these molluscs.

The technique has recently been employed by our colleague Mr. P. R. Walne to study the feeding rates of the filter-feeding gastropod *Crepidula fornicata*.

Summary.

Neutral Red is removed from solution in sea water by filter-feeding molluscs. The rate of removal is directly dependent upon the rate of passage of sea water through the gills. Simple colorimetric estimation may be used to give a comparison between filtration rates under varying environmental conditions.

The technique has been used to measure the effect of temperature and salinity upon the filtration rate of mussels (*Mytilus edulis*) and to examine the effect of parasitization by *Mytilicola intestinalis*. Examples are given of the results obtained and other applications of the technique are suggested.

References.

Allen, L. A., *et alii*, 1950. "Repeated re-use of sea-water as a medium for the functioning and self-cleansing of molluscan shellfish". J. Hyg., **48**, 431—457.

Dodgson, R. W., 1928. "Report on Mussel Purification". Min. Agric. & Fish., Fish. Invest., Ser. 2, **10**, 1—498.

Fox, D. L., Sverdrup, H. V., and Cunningham, J. P., 1937. "The rate of water propulsion in the Californian mussel". Biol. Bull., **72**, 417—438.

Galtsoff, P. S., 1926. "New methods to measure the rate of flow produced by the gills of oysters and other mollusca". Science, N. S., 63, 233—234.

Galtsoff, P. S., 1928. "Experimental study of the function of the oyster gills and its bearings on the problems of oyster culture and sanitary control of the oyster industry". Bull., U. S. Bur. Fish., **44**, 1—39.

Galtsoff, P. S., *et alii*., 1947. "Ecological and physiological studies of the effect of sulfate pulp mill wastes on oysters in the York River, Virginia". U. S. Dept. Int., Fish & Wildl. Serv., Fish. Bull., **51**, 59—186.

Gray, J., 1928. "Ciliary movement". Cambridge.

Jørgensen, C. B., 1949. "The rate of feeding of *Mytilus* in different kinds of suspension". Journ. Mar. Biol. Assoc. U. K., **28**, 333—344.

Loosanoff, V. L., and Engle, J. B., 1947. "Effect of different concentrations of micro-organisms on the feeding of oysters (*O. virginica*)". U. S. Dept. Int., Fish. & Wildl. Serv., Fish. Bull., **51**, 31—57.

MacGinitie, G. E., 1941. "On the method of feeding of four Pelecypods". Biol. Bull., **80**, 18—25.

Meyer, P. F., and Mann, H., 1950. "Beiträge zur Epidemiologie und Physiologie des parasitischen Copepoden *Mytilicola intestinalis*". Archiv f. Fischereiwiss., **2**, 3/4, 120—134.

Nelson, T. C., 1936. "Water filtration by the oyster and a new hormone effect upon the rate of flow". Proc. Soc. Exper. Biol. & Med., **34**, 189—190.

Reviews.

G. Dietrich. "Die Elemente des jährlichen Ganges der Oberflächentemperatur in der Nord- und Ostsee und den angrenzenden Gewässern". Deutsche Hydrogr. Zeitschr., **6**, 2, pp. 49—64, 7 figs. Hamburg, 1953.

The first of the five charts which illustrate this paper shows the average temperature of the surface water for the period 1906—38. The four remaining charts represent the variations of the amplitudes and phases for the second and third terms in the Fourier series, in which the average temperature forms the first term. The values on which the five charts are based were obtained by harmonic analysis of the monthly mean temperatures at seven stations, viz., the lightships "Seven Stones" in the English Channel, "Varne" in the Straits of Dover, "Hornsrev" in the eastern North Sea, and "Schultz's Grund" in the Kattegat, and the islands Christiansø in the southern Baltic, Märket in the Aaland Sea, and Ulkokalla in the northern part of the Bothnian Bay. A total of 693 series of observations, i.e., 3×33 annual series for each of the seven stations, was analysed harmonically.

From the charts giving the Fourier constants, a "normal" value for the temperature of the surface water can easily be computed for any point of time and space within the area covered.

Before beginning the extensive graphical interpolation required to represent the surface temperature over the whole North Sea and Baltic on the basis of the observations at these seven stations, the author thoroughly examined the whole collection of surface observations from the North Sea and the Baltic. The data were then adjusted so as to accord with the general results obtained by the author's detailed examination of the observations from the seven stations selected as the best in the area, from the point of view of their completeness and reliability, the length of period of observation, and the absence of local disturbances. This preparatory examination forms in fact the principal part of the paper. A detailed account of this careful research would necessarily be lengthy, and it must suffice to mention here that questions considered are, for instance, the influence of the coast's vicinity, and the depth of water, the diurnal temperature fluctuations, the spread of the average values, and the variations of the annual maxima and minima. The author also touches upon the question of long-period temperature variations, but not in great detail.

It is of interest to compare the constants obtained by Dietrich with those I myself computed on a previous occasion for Ulkokalla and Märket; the periods covered are, of course, different.[1]) For my computation, I used

[1]) "Zur Kenntnis der Temperatur und des Salzgehaltes des Baltischen Meeres an den Küsten Finnlands". Merentutk. Julk. Havforskn. Skrift., No. 122. Helsingfors, 1938; and "Harmonic Analysis of Temperature and Salinity in the Sea of Finland and Changes in the Salinity". ibid., No. 152. Helsingfors, 1952.

observations for the 1st, 11th, and 21st of each month instead of the monthly averages. The values in the following table have been amended to render the two sets of constants directly comparable.

	$A_0 = m$	$A_1 = a$	$C_1 = \alpha$	$A_2 = b$	$\frac{C_2}{2} = \beta$	$A_3 = c$	$\frac{C_3}{3} = \gamma$
			Ulkokalla				
Dietrich, 1906—38	4·89	6·82	226·4°	1·99	35·4°	0·77	75·4°
Granqvist, 1921—30 0 m.	4·8	6·6	227°	2·0	36°	0·7	74°
shore	4·9	7·0	224°	2·2	34°	0·7	73°
1921—40 shore	5·0	7·1	225°	2·0	37°	0·7	74°
			Märket				
Dietrich, 1906—38	6·29	6·94	231·6°	1·77	33·9°	0·60	88·2°
Granqvist, 1921—30 0 m.	6·1	7·1	229°	2·1	35°	0·7	90°
shore	6·0	7·1	229°	2·0	35°	0·7	92°
1921—40 shore	6·4	7·2	229°	2·0	33°	0·6	90°

These values may be supplemented by the following constants, which refer in the main to the period 1906—38. Utö is situated in the southernmost part of the Archipelago; Helsingfors is a representative station for the Gulf of Finland. Both the stations are of a high observational standard.

		$A_0 = m$	$A_1 = a$	$C_1 = \alpha$	A_2 b	$\frac{C_2}{2} = \beta$	A_3 c	$\frac{C_3}{3} = \gamma$
				Utö				
1900—13, 1921—33	0 m.	6·4	7·4	229°	1·8	28°	0·7	81°
1911—35	shore	6·7	8·1	219°	2·1	25°	0·6	87°
1921—30	shore	6·6	7·8	220°	2·1	28°	0·5	91°
1921—40	shore	7·0	8·0	221°	1·9	26°	0·4	91°
1921—30	0 m.	6·5	7·5	227°	1·9	28°	0·7	85°
				Helsingfors				
1904—35	shore	6·4	8·5	213°	2·1	24°	0·3	57°
1921—30	shore	6·6	8·6	213°	2·1	26°	0·1	52°
1921—40	shore	6·9	8·8	213°	1·9	24°	0·1	43°

These sets of values do not show any marked aberrations. They indicate similar degrees of relationship between the temperature close to the shore and somewhat farther out, at 0 m.

Finally, with the aid of Dietrich's five charts, I have computed some "normal" temperatures on arbitrarily chosen dates, for comparison with the "normal" values in the tables previously published (*loc. cit.*).

		1. May	1. June	1. July	1. Aug.	1. Sept.	1. Oct.
			Jungfruskär (in the Archipelago)				
Dietrich, 1906—38		3·0	7·7	12·8	15·7	14·8	11·0
Granqvist, 1921—30	0 m.	2·0	6·5	12·7	16·2	14·8	10·9
	shore	4·1	9·6	15·4	18·0	16·0	11·1
			Lohm (in the Archipelago)				
Dietrich, 1906—38		3·2	8·3	13·6	16·3	15·0	10·8
Granqvist, 1921—30	0 m.	2·8	8·0	13·9	16·9	15·4	11·4
	shore	3·5	9·3	15·5	18·0	16·0	11·6
			Helsingfors				
Dietrich, 1906—30		4·6	10·4	15·4	16·9	14·2	9·2
Granqvist, 1921—30	shore	4·0	9·8	15·2	17·2	14·9	9·9

In spite of differences both in the periods covered and in the methods calculation, the correspondence is quite satisfactory. The method used by author seems to result in good "normal" values.

Gunnar Granqvist.

N. G. Jerlov. "Summer Temperature and Salinity at the Swedish Lights 'Fladen'." Fish. Board Sweden, Ser. Hydrogr., Rep. No. 2, pp. 1– 4 figs. Göteborg, 1953.

On board the "Fladen" lightship, lying in the deeper part of the Katte regular observations of temperature and salinity have been made at the surf and at different depths down to 40 m. (a little above the bottom) since 19 except during the six years of war. The author therefore considered that t series of observations might be long enough to enable possible long-per temperature fluctuations to be detected especially on the observations m during the summer months (June—August) when the vertical gradient temperature is at its greatest.

His investigation is based upon the series of summer averages. As th was reason to believe that fluctuations within a short period such as 5 y are not significant, 5-year progressive means were computed. These clea show that the temperature of the water was decidedly low during the per 1927—31, and high during the period 1935—39. It appears, moreover, t the temperature curves for 0 and 5 m. representing the upper layer foll each other relatively closely, with only a slight fall in temperature from surface down. The curves for the depths from 10 to 40 m. are of anot type and show a marked and fairly regular temperature decrease towa the bottom.

The author describes the temperature distribution at "Fladen" in the w column below the upper layer by a formula which represents part of a cir This curve corresponds well both to the smoothed averages for the whole pe 1923—39, and also to those referable to the warm and cold periods anc each separate 5-year period. On the other hand, conditions in certain i vidual years, as the author points out, do not fit the curve, as is the with the whole of the period 1948—52, mainly as a result of the exception high deep-water temperatures in 1952. In the author's opinion, the existe of these anomalies indicates that the distribution of temperature cannot explained independently of other phenomena. He therefore briefly consi the salinity distribution.

His researches thus again support, in a most interesting way, the conclus of earlier authors as regards the great influence which weather conditions e upon the water stratification at the gateway to the Baltic, and confirm view that the key to the developments which may be expected in the B. is to be found in this locality.

Gunnar Granqvist

V. W. Ekman. "Studies on Ocean Currents. Results of a cruise on board 'Armauer Hansen' in 1930 under the leadership of B j ø r n H e l l a r H a n s e n". Norske Vid.-Akad. Oslo, Geofys. Publ., **19**, No. 1, P & II, 106+122 pp., 4 figs., 92 pl. Bergen, 1953.

Direct measurements of currents in deep water have been made on c paratively few oceanographic expeditions. After the remarkable serie observations by P i l l s b u r y with the "Blake" in the Strait of Florida West Indian waters in 1888—89, the next successful measurements were t obtained by H e l l a n d - H a n s e n with the "Michael Sars" in the Stra

Gibraltar in 1910, using the Ekman current-meter, which had already been used frequently in shallower water. From 1922 onwards, Helland-Hansen and Ekman made a systematic attempt to improve the instruments and methods of measuring currents, in the course of which several short expeditions were made in the "Armauer Hansen". Then in the summer of 1930 the "Armauer Hansen" was taken on a cruise to the Trade Wind region of the north-eastern Atlantic, during which six anchor stations were occupied between Portugal and the Canaries.

In the meantime the "Meteor", in the course of the German Atlantic Expedition of 1925—27, had occupied a number of anchor stations, at which current measurements were made. The instruments used were the Ekman repeating current-meter and the Ekman meter of the original type, modified by A. Merz, the leader of the expedition, who was able to profit to some extent by the experience gained from the earlier work in the "Armauer Hansen". The same two types of current-meter were used at the anchor stations of the "Snellius" expedition in Dutch East Indian waters in 1929—30.

The "Armauer Hansen" expedition of 1930 was planned and carried out by B. Helland-Hansen and V. W. Ekman, under the leadership of the former, who also took part in the preliminary analysis of the results but then had to relinquish the task. It was financed jointly from Norwegian and Swedish sources. During the period of current measurements by the "Armauer Hansen", serial observations of temperature and salinity in the same area were made by the Portuguese research vessel "Albacora", under the leadership of A. de M. Ramalho.

Some preliminary results of this expedition were published soon after its completion, but the appearance of this full account, written by V. W. Ekman, is an event of the greatest interest.

The aim of the cruise was to obtain reliable direct measurements of the average current at various depths at each station, any effects due to the movements of the ship being eliminated by making frequently repeated measurements at each depth. The observations, however, showed the existence of many variations in the current, both periodic and irregular, and much of the interest of this report lies in its description of these variations and the methods adopted for their analysis.

The "Armauer Hansen", a small wooden ship, 76 feet long, of 59 tons, was built in 1912 for the Geophysical Institute at Bergen, and was already well known for her earlier cruises in the North Atlantic. The six anchor stations of 1930 were in depths of water ranging from 1805 to 3970 m., the duration of observations at a station varying from 49 to 141 hours. The measurements were made at frequent intervals of time at depths from 5 m. down to 1000 m., with some at 1400 and 2000 m. at Station D, north of the Canaries, where the longest and most complete series of measurements was made.

One of the chief problems in making current measurements in deep water is to eliminate from the measurements the effects of movements of the current-meter due to movements of the ship. In the "Armauer Hansen", the movement of the ship was reduced by using a ratio of length of anchor cable to depth of water of only 1·05 to 1·13, except for the first two stations, where the ratio was about 1·33. Observations of the ship's bearing were made at frequent intervals, and these values, taken in conjunction with the wind observations and the surface current, as deduced from the measurements at 5 m., were used in the analysis in the attempt to eliminate any influence of the ship's movements from the current measurements.

Three types of current-meter were used simultaneously at each station. An Ekman meter of the well known type was used at depths less than 50 m. At one or two depths, usually at 50 m., an electrically recording meter of the type designed by Sverdrup and Dahl, on the "Maud" expedition, was used. In the deeper layers, the repeating current-meter, designed by Ekman in 1926, was the main instrument. Unlike the normal Ekman meter, which has to be brought up after each measurement, the repeating current-meter enables up to forty-seven measurements to be made before it is brought back to the surface.

A welcome feature of the report is the full and clear description of the methods of analysis. The primary results of the observations were the mean velocity and mean direction for each measurement, the stay of the current-meter at one depth, usually 15 or 20 minutes, being treated as one measurement. From these, the hourly values of velocity and direction were read from smooth curves drawn through the observed values. The northerly and easterly components were computed from these and were available for deriving mean values and for carrying out harmonic analyses.

Currents oscillating with the lunar semi-diurnal period were usually found, and are probably the most consistent feature of the observations. They were of the order of 10 to 15 cm./sec., sometimes reaching their maximum amplitude at 300 or 600 m. They are almost certainly tidal in origin, but often they varied quite considerably in amplitude and phase with depth, probably owing to the presence of internal waves of tidal period, superimposed on ordinary tidal currents.

Oscillations with the solar diurnal period were found with considerable amplitude at three stations, particularly at D, where they were the predominant feature in the surface layers, with amplitudes of the order of 20 cm./sec. At Stations D and E, the 24-hour period coincides very nearly with the period of free inertia oscillations, and since the water particles described approximately circular orbits in the clockwise direction, it is very probable that they are to be interpreted in this way. These particular results, originally given in a preliminary report in 1931, represent the first occasion on which inertia currents had been observed in the sea. The subsequent investigation of such currents in the Baltic by Gustafson and Kullenberg is well known. One may also recall the oscillating currents of 17-hour period observed at the "Altair" anchor station in 1938, which were interpreted as pure inertia currents.

For the last three days at Station D, the measurements in the upper layers were arranged to study the existence of a drift current of the type predicted by Ekman in his papers of 1902 and 1905. The conditions were favourable, the wind blowing from an almost constant northerly direction and with a speed varying between 5·0 and 8·6 m./sec. during that time. After removal of the diurnal and semi-diurnal oscillations, the measurements still showed considerable variations, and only by plotting mean values over 54 hours was a diagram resembling the "Ekman spiral" obtained. The evidence was not considered definitely conclusive, but the angle between the current and the wind directions, the ratio of their speeds, and the computed transport were consistent, within reasonable limits, with the theoretical predictions for a pure drift current.

After elimination of the clearly periodic constituents, the measurements in nearly all cases still showed variations. There was often a slow variation during the several days covered by the observations, which was termed a "variable mean motion", and superimposed on it were fluctuations with periods

of several hours. These fluctuations, which the author has described as "turbulence", were sometimes quite irregular, but on other occasions persisted for some time as comparatively regular motions, often tending to rotate in a clockwise direction.

The serial observations of temperature and salinity, taken either by the "Albacora" during the current measurements at a station, or by the "Armauer Hansen" after their completion, indicated considerable variations in the slopes of the isobaric surfaces. While this confirms the variability found in the currents, it makes it rather difficult to compare the measured currents with those computed dynamically. Taking this variability into account, there is fair agreement between the values found by the two methods. It is of particular interest to note that the measurements showed an easterly flow from the surface down to 300 m. north of Madeira, and a northerly or north-easterly flow at all depths down to 1000 m. off the coast of Portugal in 38°N. latitude, in agreement with the chart constructed by Helland-Hansen and Nansen on the basis of dynamic topography, although this was at variance with ideas previously held.

One is struck, on reading this paper, by the great variety of motions taking place in the sea and the difficulty of separating one type of motion from the others without drawing misleading conclusions. Although twenty-three years have elapsed between the expedition and the publication of this report, it may yet be considered to have appeared at an opportune time. Since the end of the war, the use of new techniques, such as Loran and the method of towed electrodes, has made possible great advances in the knowledge of currents in the surface layers. There has not yet been any corresponding advance in methods of studying the deep-water movements of the oceans. This will probably be one of the major tasks of Oceanography in the future, and direct measurements will almost certainly be required at the greater depths. Those who undertake this work will be able to derive inspiration and assistance from this account by Ekman of the techniques and methods of analysis, which he and Helland-Hansen have used to great advantage in their studies of ocean currents.

Since writing the above, the reviewer has heard, with deep regret, of the death of Professor Ekman. For more than half a century his researches have contributed greatly to the advance of Oceanography, and one may hope that others will be inspired to follow those lines of investigation which he has opened up, but has not lived to see explored to the full.

K. F. Bowden.

I. Hela. "The Fluctuations of the Florida Current". Bull. Mar. Sci. Gulf and Caribbean, **1**, No. 4, pp. 241—48, 1 fig. Miami, 1952.

Die kurze, aber inhaltsreiche Mitteilung des am Marine Laboratory, Miami, tätigen finnischen Ozeanographen stellt einen interessanten Versuch dar, neue Beziehungen zwischen den jährlichen Schwankungen des Floridastroms, der Wasserstanddifferenz zwischen Cat Cay und Miami Beach und der meridionalen Komponenten der mittleren Tangentialkraft des Windes in Miami Beach abzuleiten. Es zeigt sich, dass der jährliche Gang dieser 3 Faktoren (März 1938—Februar 1941) weitgehend übereinstimmt: Hauptmaximum im Juli, Hauptminimum im November. Hierbei hat Hela Gebrauch gemacht von der Sandström'schen Formel, durch welche die Beziehung zwischen Quergefälle und Stromgeschwindigkeit im Falle stationärer Verhältnisse ausgedrückt wird und die — obwohl in ihr die Reibungsgrösse nicht auftritt —

doch wohl auch für nicht reibungsfreie Ströme gültig ist. Will man Reibungsfaktor ermitteln, so wäre es wohl nötig, das Längsgefälle zu Stromstärken in Beziehung zu setzen. Für die wichtige Frage der wechselsei Beeinflussung von Ozean und Atmosphäre im Golfstromsystem wäre überh eine systematische Untersuchung über die Schwankungen des Floridast der Wasserstände an seinen Rändern, und der Windstärken von gr Bedeutung. Wir stehen in diesem, letzten Endes auch für die Wetterpro bedeutungsvollen Problem noch ganz in den Anfängen, und was vor not tut, ist auch hier: neues exakteres Beobachtungsmaterial.

Georg Wüs

J. R. Rossiter. "The North Sea Storm Surge of 31 January and 1 Febr 1953". Phil. Trans., Roy. Soc. London, Ser. A, **246**, No. 915, pp. 3 400, 9 figs. London, 1954.

Die Sturmflutkatastrophe in Holland und Südostengland vom 31. 1. 1. 2. 1953 hat die Diskussion um die Ursache der Nordseesturmfluten belebt. Unter der grossen Zahl der über diese Sturmflut bisher veröf lichten Arbeiten nimmt die Untersuchung von Rossiter eine beso Stellung ein, da sie sich nicht auf die Darstellung des Verlaufs der W standsänderungen an einzelnen Küstenabschnitten beschränkt. Der Verf setzt sich vielmehr "eine Analyse des Sturmflutmechanismus in der gesa Nordsee" zum Ziel. Zu diesem Zwecke wurden aus den Pegelaufzeichnu von 31 ausgewählten Küstenstationen rings um die Nordsee und 2 Stati am Ostausgang des Kanals die Änderungen des mittleren Wasserstand stündlichen Werten berechnet und daraus in enger Anlehnung an die A von Corkan über die Sturmflut vom 8. 1. 1949 Nordseekarten entwo die für bestimmte Zeiten "Linien gleichen Windstaus" (co-disturbance enthalten. Diese Karten geben einen Überblick über die windbedingte Nei der Meeresoberfläche und ihre Änderung während der Sturmtage. Gleich wird die Entwicklung der Wetterlage an Hand von Wetterkarten gezeigt. Darstellungen werden miteinander verglichen und im einzelnen bespro Durch Planimetrieren berechnet der Verfasser dann die zusätzliche W menge, die während der Sturmtage aus dem Atlantischen Ozean in die No eingeströmt sein muss. Für die Zeit der maximalen Abweichung des mitt Wasserstandes (31. 1. abends bis 1. 2. nachmittags) ergibt sich für das Seeg zwischen der Strasse von Dover und der geographischen Breite der Shet Inseln ein Wasserüberschuss von 425 Milliarden Kubikmeter. Dieser Ü schuss wird kompensiert durch ein Absinken des mittleren Wasserst entlang der Küste Mittelnorwegens um 0·5 bis 1 Meter. Die Karten g dem Verfasser ausserdem die Möglichkeit, den Reibungskoeffizienten k die Schubkraft des Windes auf die Meeresoberfläche empirisch zu bestim Die Voraussetzung dafür (stationäre Neigung der Meeresoberfläche bei definierten Windverhältnissen) war allerdings nur angenähert erfüllt. T dem ergeben sich mit $k = 0{\cdot}0025$ und $k = 0{\cdot}0017$ befriedigende W Schliesslich bestimmt der Verfasser an Hand von Spezialkarten für den ausgang des Kanals den Wasserdurchfluss durch die Strasse von D während der Sturmflut, der dem Wasserstandsgefälle entsprach. Es e sich für den 1. 2. eine mittlere Stromgeschwindigkeit von 2 sm./h., was Fallen des Wasserstandes zwischen der Themsemündung und der belgis Küste von 0·3 m./h. zur Folge gehabt haben muss. Die inzwischen Lawford veröffentlichten Auswertungen der Strommessungen auf Feuerschiff "Varne" ergeben etwas geringere Geschwindigkeiten (Mittelwert

l., 18 Uhr, bis 1. 2., 19 Uhr: 1·2 sm./h.). Sie bestätigen aber ebenso die nung des Verfassers, dass die Strasse von Dover für die südliche Nordsee ine Art "Sicherheitsventil" bei Sturmfluten anzusehen ist. Die Rechnungen en, dass solche synoptischen Darstellungen für das Verständnis des Sturm- nechanismus einen grossen Wert besitzen. Der Referent möchte aber an Entwürfe der "co-tidal charts" durch W h e w e l l erinnern, die zu falschen üssen Anlass gaben. Eine gewisse Vorsicht beim Entwurf der "co-distur- ce charts" scheint daher geboten. Messungen des Wasserstandsverlaufes im en Seegebiet standen dem Verfasser nicht zur Verfügung, er ist bei seinen würfen also auf die Messwerte der Küstenpegel angewiesen. Wenn er im blick auf die grosse Zahl der verwendeten Küstenbeobachtungen auch der nung ist, dass sie grössere Fehler kaum enthalten werden, so bleibt doch edenken, dass die örtlich gemessenen Werte vielfach von der Gestaltung Küste und des Küstenvorlandes abhängig sind und häufig nicht als räsentativ für das freie Seegebiet angenommen werden dürfen. Es ist halb nicht verwunderlich, dass G r o e n in ähnlichen Entwürfen zu dieser rmflut zu teilweise anderen Ergebnissen gekommen ist (Kon. Nederl. eorol. Inst., Rapp. 4, No. 6, 1953). Die Diskussion um die "co-disturbance rts" wird jedoch sicher recht fruchtbar sein. Es wäre zu wünschen, für Entwurf solcher Karten auch einmal auf eine Reihe von Messpunkten im en Seegebiet zurückgreifen zu können. Abschliessend befasst sich der Ver- er mit der Vorausberechnung des Windstaus für Southend und gibt einen zen Überblick über die Entwicklung der englischen Vorhersageverfahren ch D o o d s o n, P r o u d m a n und C o r k a n. Die von letzterem ein- ihrten Vereinfachungen hält er nicht mehr für berechtigt, da nunmehr ügend Beobachtungsmaterial zur Bestimmung aller Konstanten vorliegt. Es im Gegenteil nötig, weitere Glieder in die Gleichung für den Windstau Southend aufzunehmen, die den Einfluss der Strasse von Dover im Süden (Ab- s des Wassers) und des Seegebietes vor der norwegischen Küste im Norden strom von Wasser) erfassen sollen. Eine entsprechende Neubearbeitung der ndstauvorhersage soll ausserdem die Frage des Dämpfungsverhältnisses bei illationen im Falle aussergewöhnlicher und langanhaltender Stürme auf und der vollständigen Schwingungstheorie neu in Angriff nehmen.

G. Tomczak.

Thiel. "Die Wirkungen des Luft- und Winddruckes auf den Wasserstand in der Ostsee". Deutsche Hydrogr. Zeitschr., **6**, H. 3, pp. 107—23, 7 Abb. Hamburg, 1953.

The paper is an interesting contribution to our knowledge of sea-level iations in the Baltic, a subject which is important not only from the oretical point of view, but, especially in extreme cases, for practical poses too.

The author begins by examining the influence of local air-pressure on -level for days with calm weather, or with so little wind that its effect s practically negligible. For three different series of observations, he obtains onnexion between the two variables, in which the observed values correspond te satisfactorily with the theoretical. Cases with weak winds persisting a relatively long period are, however, infrequent. The influence of wind ssure is, as a rule, a very important factor, but the piling up of water that causes is a complicated question depending greatly upon the direction, ce, and duration of the wind. In order to simplify the problem the author roduces the air-pressure differences, or gradients, as characteristics of the

weather situation in the Baltic and the North Sea. The use of a large area is without doubt an advantage in this connexion. With these differences the author establishes an empirical formula, which gives the variation in sea-level for Kiel Bay as a square function of the mean gradient. This formula is applicable to all cases when the main direction of the gradient is south—north or *vice versa*, corresponding to north-easterly and south-westerly winds respectively. The author shows by numerical examples that with a north-easterly gale over the Baltic and the North Sea, sea-level is low in the eastern part of the Baltic, in the Kattegat, and the eastern North Sea, while a high water-level occurs in the western part of the Baltic and in the Belts. For Kiel Bay the observed sea-level corresponds closely with the value computed from the formula. For south-westerly gales, with high sea-level in the eastern Baltic and in the Kattegat, and low sea-level in the western parts of the Baltic the results are not quite satisfactory.

In the last section of his paper the author applies his method to the disastrous storm-surge of 13. November 1872, in the south-western Baltic, and to the great storm-surge of 23. September 1924, in the innermost part of the Gulf of Finland. In the first of these cases the applicability of this method is clear, and the correspondence between the observed and the computed sea-levels for Kiel Bay is very good. In considering the storm-surge in 1924, however, the author was forced to modify his simple method and operate with gradients over the Gulf of Finland. Using these values in the formula deduced for Kiel Bay he attains a good agreement between observed and calculated sea-levels. This permits the inference that this storm-surge also was caused only by the wind force. It would, however, be interesting to ascertain, with more extensive data, whether the formula deduced for a region differing in so many respects from the Gulf of Finland is in fact applicable to this basin also. In an earlier paper (V. Hydrol. Konf. Balt. Staaten, Bericht 15D) quoted by the author, S t e n i j has already attempted to explain the storm-surge in question and has shown that the coincidence of several different factors was the cause of the exceptionally high sea-level in the inner parts of the Gulf of Finland.

E. L.

F. S. Russell. "The Medusae of the British Isles". Cambridge University Press, pp. 1—530, 319 figs., 35 pl. Cambridge, 1953.

F. S. R u s s e l l's admirable monograph of the British hydromedusae must be welcomed with the greatest pleasure and satisfaction, not merely by specialists of the group, but by everybody interested in the animal life of the sea. It is written in such a way that anybody with some training in zoological research may make use of it for identification of species of jellyfish met with around the British coasts, and also find great pleasure in reading about the elegant structure and peculiar life-history of these most interesting creatures. From an aesthetic point of view the book is indeed a work of artistic splendour. The 35 plates, many of which are in colours, are a delight to the eye, besides giving a precise portrayal of the appearance of the animals. Almost all the figures in the plates are drawn by Mr. R u s s e l l himself, and so are also most of the 319 figures in the text. These illustrate structural details and developmental stages, and are supplemented by reproductions of figures from the literature. The illustrations of preserved specimens in the crumpled and contorted states in which they are frequently found in the plankton samples is a splendid idea.

For readers not previously well acquainted with the medusae, a very practical exposition of their morphology is given in the first chapters of the book. This is followed by a general account of the life-history and seasonal and regional distribution around the British Isles, a description of the methods of rearing hydroids and medusae, and advice for collecting and preservation. An entirely new idea is a "pictorial key" on four pages, with small figures of almost all the British species, which provides a rapid means of identification.

The great difficulty in the classification of medusae is their relation to the hydroids from which most of them are derived. In most species the hydroid is unknown, and where the hydroids are known we frequently find that species which are generally considered closely related produce medusae belonging to different genera or even families. Many years' careful studies and experiments by Russell and his collaborator, W. J. Rees, have resulted in the rearing of hydroids of several species of British medusae, and from these new findings Russell has been able to make considerable progress in the attempt to obtain the common classification of medusae and hydroids which we have looked upon as a future, though distant goal. In accordance with this fresh knowledge Russell has divided the genera of antho- and leptomedusae into a greater number of families than has been usual up to now. There may be different opinions on the nomenclature applied to the genera (personally I agree with Russell in this respect), but the classification introduced in the present book is certainly an important advance.

The number of species of hydromedusae found in the British waters now amounts to 90, and all are thoroughly discussed from all points of view: description of adult, distribution in British waters as well as abroad, developmental stages and structural details, seasonal occurrence, the hydroid (if known), and the history of the species, all based on careful and critical studies. In the clear and concise diagnoses and descriptions of genera and species one recognizes the influence of the late E. T. Browne, under which the author (like the present writer) has come. For many years Mr. Browne had collected notes for a future monograph on British medusae, and a few years before his death in 1937 he encouraged Russell to take up this comprehensive task, which has now been fulfilled in such an admirable way. Russell has devotedly expressed his gratitude to the old master and benefactor to science.

I congratulate the author on the completion of this work, and I commend to British biologists this important contribution to the knowledge of the fauna around their coasts.

P. L. Kramp.

W. J. Rees. "The *Macrotritopus* Problem". Bull. British Mus. (Natur. Hist.), Zool., **2**, No. 4, pp. 69—99, 17 figs., 1 pl. London, 1954.

The paper contains a revision of nearly all known specimens of the "genus" *Macrotritopus* (Octopodidae) from the Atlantic. From this ocean four species have been described by previous authors: *M. equivocus* Robson, *M. scorpio* (Berry), *M. kempi* Robson, and *M. danae* Joubin and Robson. Besides these some larvae referred by Degner (1925) to *Scaeurgus* sp. have been studied. The whole available material was measured in the manner generally adopted by students of Cephalopoda, and the relation between ventral mantle length and a number of other measurements, such as mantle width, head width, length of arms, is shown in some very instructive graphs.

The author concludes that the whole material comprises one species only. All the known "species" of *Macrotritopus* are juveniles, and by means of radula preparations the author is able to demonstrate that they are the juveniles of *Scaeurgus unicirrhus* (delle Chiaje), the distribution of which extends over the warmer parts of all three oceans, where it lives in fairly shallow water.

Besides the conclusion just mentioned, which is extremely interesting from a systematical point of view, the paper contains much information about the biology of the young *Scaeurgus*. One chapter is devoted to a discussion of the breeding season. In the Mediterranean spawning seems to take place mainly in June—July. In the Atlantic breeding may occur all the year round, but there may be local variation as a result of differences in hydrographical conditions.

The author considers that the pelagic life in juvenile *Scaeurgus* lasts three to five months, and several features such as the prolonged third pair of arms, the squid-like shape of the body, the high number of gill filaments, and the colour pattern may be interpreted as adaptations for a pelagic life of considerable duration. It was observed that one specimen fished in shallow water in the Mediterranean was developing a hectocotylus at a size of 6—7 mm. ventral mantle length, while other specimens had attained a considerably larger size without attaining sexual maturity. It was found that these specimens were invariably obtained from waters outside the shelf, off the Antilles and West Africa. In the author's opinion this is a parallel to the phenomenon which has been studied by W i l s o n and others, viz., that pelagic larvae which are unable to find a suitable substratum for metamorphosis will delay this for a considerable time, during which their growth will continue. The narrow shelf of the two areas mentioned above may account for the fact that these "extended pelagic stages" have been found in offshore waters of these regions. The "extended pelagic stages" may contribute to a considerable extent to the dispersal of the young, and it is suggested that this may be the cause of the remarkable uniformity of the stocks of *Scaeurgus unicirrhus* throughout the oceans — a fact already pointed out by B e r r y (1914).

These observations are of the utmost importance, because it has been possible to demonstrate a correlation between the variability and the mode of life of the pelagic larvae in a marine invertebrate. It is much to be hoped that the author of this valuable paper would, for comparison, study a species having a short pelagic life — which might be expected to exhibit a greater variability from one place to another, because of the more or less complete isolation of the stocks inhabiting different areas.

Besides the graphs already referred to, the paper is accompanied by a number of very fine figures. It would have been useful, however, if the author had also given a map showing the known distribution of larval and adult *Scaeurgus*.

J. Knudsen.

S. G. Brown. "Dispersal in Blue and Fin Whales". Discovery Rep., **26**, pp. 355—84, 14 figs. Cambridge, 1954.

In 1940 R a y n e r published the first results from the extensive whale-markings which the Discovery Committee had arranged in the Antarctic during the period 1932—39, when more than 5,000 whales were marked. During the time which has passed since R a y n e r's report more marks from this period of marking have been returned, and up to the close of the 1951—52 antarctic whaling season altogether 50 marks have been returned

from 45 blue whales and 218 marks from 208 fin whales. This material forms the basis of B r o w n' s paper, which he regards "as an interim report, mainly concerned with dispersal in time, which is examined on a quantitative basis".

The author discusses the dispersal in blue and in fin whales separately. "Time-charts" and histograms showing the dispersal are given.

It was found by R a y n e r and is further confirmed by the author that some blue whales and many fin whales return year after year to somewhere near the places where they were marked.

In fin whales which have dispersed, he finds that the dispersal appears to be limited to within 50° east or west of the position of marking, and that 34 % of "short-term" recoveries (recovered within 2 seasons after marking) have dispersed, compared with 60 % of "long-term" recoveries. B r o w n also makes the interesting suggestion that dispersal may take place among younger whales of the population rather than among older whales.

A higher proportion of marked blue whales show dispersal than is the case in fin whales, and they disperse over greater distances than fin whales, one blue whale having moved through almost 87° of longitude.

The movements of blue and fin whales between the antarctic whaling areas are discussed.

An appendix gives a complete list with available data of marks returned from antarctic blue and fin whales up to the close of the 1951—52 season.

B r o w n' s paper will be read with keen interest by all scientists concerned with whale biology. At present whale markings are needed more than ever, and B r o w n' s report shows clearly how important whale markings are in the whale research work.

Åge Jonsgård.

K. H. Doan and C. W. Douglas. "Beluga of the Churchill region of Hudson Bay". Bull. Fish. Res. Board Canada, No. 98, pp. 1—27, 7 figs. Ottawa, 1953.

In 1947 when it became apparent that a commercial catch of beluga (*Delphinapterus leucas*) would be attempted on a comparatively large scale at Churchill in the eastern part of the Hudson Bay, studies were initiated. During the period 1947 to 1950, personnel from the Central Fisheries Research Station of the Fisheries Research Board of Canada collected materials from, and gathered information on, the beluga of the Churchill region. Data of catch and production in 1951 were also made available to the Research Board.

The paper by D o a n and D o u g l a s on the general biology of the beluga is based on this material. In addition they give information on the hunting and the utilization of the beluga.

A description of the species is given with information on length-distribution, weight, colour, and teeth. The investigations of the colour suggest a taxonomic difference between the Churchill beluga and the beluga of the St. Lawrence.

The distribution and the abundance of the Churchill beluga have been studied, *inter alia*, by means of aerial observations. It was found that it increased in abundance in the vicinity of Churchill until midsummer, but with the onset of the fall storms it rapidly disappeared from the area. In the mouths of the Churchill and Seal rivers and along the intervening coast more than 1600 animals were counted on 1. August 1950.

Interesting information is given with regard to the food habits of the Churchill beluga. Its parasites have also been studied.

With regard to reproduction the authors found that the females attain sexual maturity at a length of 9 feet at a probable age of 3 years. Mating takes place in the spring; size measurements of 49 embryos indicated that more than three-quarters of the conceptions occurred in May. In one case twins were found. Evidence of head presentation at birth was observed.

A special way of marking live beluga by tattoo is described. In 1949 and 1950 eleven animals were certainly marked and four more possibly marked, but no recoveries were obtained.

In the introduction a historical review of the catch of beluga in the Hudson Bay waters is given.

Åge Jonsgård.

K. Bahr. "Beiträge zur Biologie des Flussneunauges, *Petromyzon fluviatilis* L. (Lebensraum und Ernährung)". Zool. Jahrb. (Syst.), **81**, H. 4, pp. 408—436. Jena, 1952.

The experiments described in this article were designed to test the tolerance of the lampern (*Lampetra fluviatilis* (L.)) to changes in salinity at two periods in its life, the feeding phase in salt water and the beginning of the spawning migration from salt to fresh water. All the experimental animals were caught by the fishermen of Cuxhaven in the estuary of the Elbe, where the water is subject to wide fluctuations in salinity with wind and tide, and they were kept in a tank of fresh water for two weeks. They were then transferred in pairs, gradually or suddenly, to vessels containing water of various salinities. The September lamperns were found to be much more tolerant of increased salinity than those caught in December or January. All the latter were sexually ripe animals; the former included young lamperns, which presumably would not have spawned in the following season, as well as sexually mature animals which would have spawned six months later. This result was to have been expected, and the experiments demonstrate that the physiological change from euryhaline to stenohaline is part of the mechanism that brings the lampern to its freshwater spawning beds. As the author points out, this is similar to the narrowing salinity tolerance of the sexually maturing tunny and eel, and there are many other examples of fish migrations in which salinity is the governing factor.

Herr Bahr's experiments also demonstrated an increase in respiration rate and a loss of weight in lamperns transferred to water of higher salinity. He attributes the loss of weight to the work involved in osmoregulation, but other possibilities will readily come to mind.

Experimental results and field observations lead the author to conclude that the lampern of the Elbe does not migrate farther seawards than the estuarine region.

The second part of the paper gives some observations on the feeding of lamperns. Living fishes placed in the freshwater tanks as food were not attacked either by the sexually ripe lamperns or by those caught in June or September. In some cases, however, the lamperns attached themselves to each other, making superficial wounds. This never happened in the salt-water tanks, but in these some of the sexually immature animals attacked living flatfish, but only after these had been in the tank with them for some time. Herr Bahr presents evidence that plankton, taken in through the gill openings with the respiratory current, is a subsidiary food of the lampern.

He is inclined to minimize evidence given by Ladiges that carrion forms a considerable part of the diet, and he attributes the many lampern-wounds found on fishes in Cuxhaven market to attacks on the living fishes, rather than upon dead or moribund fish in the nets.

The author does not tell us why he puts the lampern back into the genus *Petromyzon*, contrary to general modern practice. On p. 425 a space-wasting graphical device is used, which is unnecessary for anyone past the abacus stage of numerical expression.

Herr Bahr's experiments are interesting and suggestive, although proof would require them to be carried out on a larger scale. He is to be congratulated, however, on obtaining even so many lamperns during their salt-water phase and in the early months of the spawning migration, and on keeping them healthily in tanks.

E. Trewavas.

B. Baggerman. "Spatfall and transport of *Cardium edule* L.". Arch. Néerlandaises Zool., **10**, No. 3, pp. 315—342, 6 figs. Leiden, 1953.

By ingenious experimental methods Miss Baggerman has obtained much new information regarding the transport by tides and currents of post-larvae and early settled stages of *Cardium edule, Mytilus edulis, Macoma baltica, Mya arenaria,* and *Petricola pholadiformis.* It is shown that transport of *Cardium* in large numbers occurs in the Dutch Waddensee, in the area studied, up to a shell length of approximately 2·0 mm. *Mytilus* are transported up to a length of 1·8 mm.; *Mya* up to 2·5 mm.; *Macoma* up to 3·0 mm., and *Petricola* up to 1·2 mm.

The work is important because it shows that the final pattern of distribution of these molluscs is not that produced by setting, followed by differential death, but by setting plus transport, modified by death. Transport seems to exert a major effect on the distribution of *Cardium*, and neglect of this factor may explain several puzzling anomalies recorded in earlier studies. It is believed that the largest individuals transported (2·0 mm.) had settled at least a month before.

On the grounds studied, post-settlement *Cardium* were accumulated in areas of slack currents in fine sand, and a similar pattern has been observed on some British beds. Spatfall occurred from the first half of May until at least the second half of July, with a peak near the end of May. Data on the settlement of other molluscs is less extensive but *Mytilus* appeared to settle mainly from mid-May to mid-July, *Mya* from early May till the end of June, and *Macoma* during April and May.

Miss Baggerman was not able to plot the early settlement pattern of *Cardium* as it proved to be impossible to separate individuals below 0·6 mm. from the sand by sieving, and for this aspect of the work other methods will have to be employed. There remains, too, the possibility of a gregarious tendency during settlement such as has been shown to be of importance in forming distribution patterns among recently settled oyster spat.

H. A. Cole.

Current Bibliography.

Prepared by the Editor with the Assistance of Mr. A. R. Margetts.

NOTE. The scope of the Bibliography is limited in the main to the area covered by the Council's activities, but there are included papers of general interest relating to other areas in North Temperate and Arctic regions and exceptionally elsewhere. Limnological references are not as a rule given, but papers relating to brackish waters and to salmon and freshwater fish studied by the Council are included.

Subscribers and those on the distribution list will receive regularly upon application to the General Secretary copies of the Bibliography printed on one side of the page only, for use in making up card indices.

The Editor will be glad to be advised of emendations and additions to the Bibliography.

1) General Oceanography.

1) a Expeditions.

Devold, F. "Tokter med 'G. O. Sars' i Norskehavet sommeren 1953". Fiskets Gang, 49, pp. 626—9. Bergen, 1953.

Nybelin, O. "Introduction and station list". Rep. Swedish Deep-Sea Exped., **2**, Zool., 1, pp. 1—28. Göteborg, 1951.

Rokstad, G. "Rapport. Forsøkslinefiske med m/s 'Thor Iversen' i Barentshavet 3/10—22/10—53". Fiskets Gang, 50, pp. 638—40. Bergen, 1953.

1) b Institutes.

Anon. "Annual Report of the Fisheries Research Board of Canada 1952". Ottawa, 1953.

Anon. "Annual report for the year 1953". Inst. Seaweed Res. Inveresk, 1954.

Anon. "Annual Report of the National Oceanographic Council 1951—52". Cambridge, 1953.

Anon. "Annual Report of the Woods Hole Laboratory for the year ending 30th June, 1953". U. S. Dept. Interior, Fish & Wildlife Service. Woods Hole, Mass., 1953.

Anon. "First, second, third and fourth reports of the Commission (covering the years 1st June, 1949 to 31st May, 1953)". Internat. Comm. Whaling. London, 1950/53.

Anon. "International Commission for the Northwest Atlantic Fisheries". Ann. Proc., **3**, 1952—53. Halifax, N. S., 1953.

Anon. "Inter-American Tropical Tuna Commission". Ann. Rep. 1952, pp. 3—61. La Jolla, California, 1953.

Anon. "The Marine Biological Laboratory. Fifty-fifth report, for the year 1952 — sixty-fifth year". Biol. Bull., **105**, 1, pp. 1—46. Woods Hole, Mass., 1953.

Burdon, T. W. "Report of the Fisheries Department, 1951". Colony of Singapore, 1952.

Burdon, T. W. "Report of the Fisheries Department 1952". Colony of Singapore, 1953.
Petit, G. "Rapport sur le fonctionnement du Laboratoire Arago en 1951—52". Vie et Milieu, **3**, 4, pp. 458—70. Paris, 1952.
Petit, G., & Trégouboff, M. "Rapport sur le fonctionnement de la Station Zoologique de Villefranche-sur-Mer. Octobre 1951—Octobre 1952". Vie et Milieu, **3**, 4, pp. 471—3. Paris, 1952.
Wheeler, J. F. G. "First report of the East African Marine Fisheries Research Organisation, 1952". East Africa High Commission. Nairobi, 1953.

2) Hydrography.

2) a Apparatus and Methods.

Barnes, H. "A double syringe-pipette for dissolved oxygen estimations". The Analyst, **78**, 929, pp. 501—3. London, 1953.
Bruneau, L., Jerlov, N. G., & Koczy, F. F. "Physical and chemical methods". Rep. Swedish Deep-Sea Exped. 1947—48, Physics & Chemistry, **3**, 2. Göteborg, 1953.
Flöisand, K., & Sælen, O. H. "On the use of punch-cards machines for dynamic computations in oceanography". Norsk Regnesentral, Avd. ved Geofys. Inst. Bergen, 1953.
Schaniel, C. L. "A camera for photographing bathythermograph slides". Journ. Mar. Res., **12**, 3, pp. 277—9. New Haven, Conn., 1953.
Schmidt-Reis, H. "Trübungsmessungen, eine Möglichkeit zur einfachen und schnellen Feststellung von Veränderungen in Gewässern. 1. Fliessende Binnengewässer". Arch. f. Hydrobiol., **47**, 4, pp. 489—515. Stuttgart, 1953.
Yamaguti, S. "Sur le thermomètre a renversement du type Yosino". Marit. Safety Agency, Hydrogr. Bull. 36. Tokyo, 1953. (In Japanese).

2) b Surveys.

Andersen, K. P., Böhnecke, G., Craig, R. E. (and Lovegrove, T.), Dannevig, A., Hermann, F., Jerlov, N., Koczy, F., Johnston, R., Letaconnoux, R., Postel, E., Smed, J., Stefánsson, U., Tait, J. B., Thomsen, H. "Hydrography". Cons. Internat. Explor. Mer, Ann. Biol., **9**. Copenhague, 1953.
Jerlov, N. G. "Summer temperature and salinity at the Swedish lightship 'Fladen'". Fish. Bd. Sweden, Ser. Hydrogr., Rep. 2. Göteborg, 1953.
Maéda, H. "Studies on Yosa-Naikai. 2. Considerations upon the range of the stagnation and the influences by the river Noda and the open sea". Journ. Shimonoseki Coll. Fish., **3**, 2, pp. 133—40. Shimonoseki, 1953. (In Japanese, English summary).
McGary, J. W., & Sieling, F. W. "Chemical and physical data Chincoteague Bay area — July 1943 to June 1953". Chesapeake Bay Inst. Johns Hopkins Univ., Data Rep., Ref. 53—10. Annapolis, 1953.
Mosby, H. "Oceanographical investigations at Weather Ship Station M". Univ. Bergen. Årbok 1953, Naturvid. Rk., 10. Bergen, 1954.
Pritchard, D. W. "Patuxent River Spring Cruise 3rd April—8th April 1952". Chesapeake Bay Inst. Johns Hopkins Univ., Data Rep. 16, pp. 1—55. Annapolis, 1953.
Pritchard, D. W. "Choptank River Spring Cruise 28th April—1st May, 1952". Chesapeake Bay Inst. Johns Hopkins Univ., Data Rep. 17, pp. 1—37. Annapolis, 1954.
Romanovsky, V., Francis-Boeuf, C., & Bourcart, J. "La Mer". Librairie Larousse, 503 pp. Paris, 1953.
Soule, F. M., Branson, P. S., & Dinsmore, R. P. "Physical oceanography of the Grand Banks region and the Labrador Sea in 1951". U. S. Coast Guard Bull., 37, pp. 17—85. Washington, 1952.
Soule, F. M. "Physical oceanography of the Grand Banks region and the Labrador Sea in 1952". U. S. Coast Guard Bull., 38, pp. 31—100. Washington, 1953.

2) c Chemistry of Sea Water.

Anon. "Atlas des Salzgehaltes, der Wassertemperatur und der Strömungen im Mittelmeer". Seehydrogr. Dienst, Hydro-Meteorolog. Inst. Berlin, 1952.
Anon. "New hydraulics research station". Dock Harbour Auth., 395. London, 1953.
Brouardel, J., & Fage, L. "Variation de la teneur en oxygène de l'eau au proche voisinage des sédiments". Deep-Sea Res., **1**, 2, pp. 86—94. London, 1954.
Lineikin, P. S. "On the change of salinity of the surface layer of the sea during precipitation". Izvest. Akad. Nauk. S. S. S. R., Ser. Geofiz., 2, p. 148. Leningrad, 1953.

Maéda, H. "The relation between chlorinity and silicate concentration of water observed in some estuaries. II". Journ. Shimonoseki Coll. Fish., **3**, 2, pp. 167—80. Shimonoseki, 1953. (In Japanese, English summary).

Saruhashi, K. "On the total carbonaceous matter and hydrogen ion concentration in sea water. A study on the metabolism in natural water". Pap. Meteorol. & Geophys., **3**, 3. Tokyo, 1953.

Tucker, M. J. "Sea wave recording". Dock Harbour Auth., 397. London, 1953.

Tucker, M. J. "Oil pollution of the sea". Dock Harbour Auth., 397. London, 1953.

2) d Physical Properties.

Herdman, H. F. P. "The deep scattering layer in the Sea: Association with density layering". Nature, **172**, 4372, pp. 275—6. London, 1953.

2) e Temperatures.

Anon. "Atlas des Salzgehaltes, der Wassertemperatur und der Strömungen im Mittelmeer". Seehydrogr. Dienst, Hydro-Meteorolog. Inst. Berlin, 1952.

Eggvin, J. "Sjøtemperaturen våren og forsommeren, 1953". Fiskets Gang, 29, pp. 353—6. Bergen, 1953.

Goedecke, E. "Zur 'klimatischen' Verlängerung der Badesaison an der deutschen Nordseeküste". Ann. Meteorol., 9, pp. 1—6. Hamburg, 1954.

Rasmussen, B. "Om fløytelinefisket i Holstensborgdjupet Vest-Grønland, 1953". Fiskets Gang, 13, pp. 160—6. Bergen, 1954.

Romanovsky, V. "Les variations de la température des eaux superficielles dans le détroit de Messine". Bull. d'Inform., Com. Centr. Océanogr. Etude Côtes, **6**, 3, pp. 101—4. Paris, 1954.

Southward, A. J. "Fluctuations in the sea and air-temperatures at Port Erin during the past fifty years". Ann. Rep. 1952 (65), Mar. Biol. Stat. Port Erin, Isle of Man, pp. 28—31. Liverpool, 1953.

Wiseman, J. D. H. "The determination and significance of past temperature changes in the upper layer of the equatorial Atlantic Ocean". Proc. Roy. Soc., A, **222**, pp. 296—323. London, 1954.

2) g Hydrodynamics.

Batchelor, G. K. "The theory of homogeneous turbulence". Cambridge Monogr. Mech. & Appl. Math., 197 pp. Cambridge, 1953.

Einstein, H. A., & Harder, J. A. "Velocity distribution and the boundary layer at Channel bends". Trans. Amer. Geophys. Union, **35**, 1, pp. 114—20. Washington, 1954.

Goldsbrough, G. R. "Wind effects on the motion of the sea in an infinite channel and in a rectangular gulf". Proc. Roy. Soc., A, **222**, pp. 477—89. London, 1954.

Hoiland, E. "On the dynamic effect of variation in density on two-dimensional perturbations of flow with constant shear". Geophys. Publ., **18**, 10. Bergen, 1953.

Hoiland, E. "On two-dimensional perturbation of linear flow". Geofys. Publ., **18**, 9. Bergen, 1953.

Stommel, H. "Examples of the possible role of inertia and stratification in the dynamics of the Gulf Stream system". Journ. Mar. Res., **12**, 2, pp. 184—95. New Haven, Conn., 1953.

Vandorn, W. G. "Wind stress on artificial pond". Journ. Mar. Res., **12**, 3, pp. 249—76. New Haven, Conn., 1953.

Watson, E. E. "An experiment to determine the hydrodynamic forces on a cable inclined to the direction of flow". Journ. Mar. Res., **12**, 3, pp. 245—48. New Haven, Conn., 1953.

2) h Currents and Oceanic Circulation.

Anon. "Atlas des Salzgehaltes, der Wassertemperatur und der Strömungen im Mittelmeer". Seehydrogr. Dienst, Hydro-Meteorolog. Inst. Berlin, 1952.

Backhausen, F. "Über Stromversetzungen im arabischen und bengalischen Meer während des SW-Monsuns". Der Seewart, **14**, 5. Hamburg, 1953.

Bougis, P., & Ruivo, M. "Sur une descente d'eaux superficielles en profondeur (cascading) dans le sud du Golfe du Lion". Bull. d'Inform., Com. Centr. Océanogr. Etude Côtes, **6**, 4, pp. 147—54. Paris, 1954.

Cromwell, T. "Circulation in a meridional plane in the central Equatorial Pacific". Journ. Mar. Res., **12**, 2, pp. 196—213. New Haven, Conn., 1953.

Ekman, V. W. "Studies on ocean currents". Geofys. Publ., **19**, 1. Bergen, 1953.
Hidaka, K., & Tsuchiya, M. "On the Antarctic Circumpolar Current". Journ. Mar. Res., **12**, 2, pp. 214—22. New Haven, Conn., 1953.
Lawford, A. L. "Currents in the North Sea during the 1953 gale". Weather, **9**, 3, pp. 67—72. London, 1954.

2) i Tides and Sea Level.

Egedal, J. "Tidal observations in Greenland in the years 1934—51". Nautisk-Meteorolog. Årbog, 1952. København, 1953.
Groen, P. "Voorlopig onderzoek van de waterstanden opgetreden langs de kusten der Noordzee op 31 Jan. en 1 Feb.". Kon. Nederl. Meteorol. Inst. (Afd. Oceanogr. Mar. Meteorol.), Rapp. 4, 6. Utrecht, 1953.
Hela, I. "A study of land upheaval at the Finnish coast" Fennia, **76**, 5, pp. 3—38. Helsingfors, 1953.
Keulegan, G. H. "Characteristics of internal solitary waves". Journ. Res., Nation. Bur. Standards, **51**, 3, pp. 133—40. Washington, 1953.
Maruszczak, H. "Istota i przyczyny zmian poziomu morza". 33 pp. Wroclaw, 1952.
Thiel, G. "Die Wirkungen des Luft- und Winddruckes auf den Wasserstand in der Ostsee". Deutsch. Hydrogr. Zeitschr., **6**, 3, pp. 107—23. Hamburg, 1953.
Wilson, B. W. "Oscillations of the sea and the phenomenon of range". Dock Harbour Auth., 392—6. London, 1953.
Yamaguti, S. "Sur le niveau moyen de la mer". Marit. Safety Agency, Hydrogr. Bull., 36. Tokyo, 1953.

2) j Geography, Geology and Bottom Deposits.

Bullard, E. C. "Heat-flow through the floor of the ocean". Deep-Sea Res., **1**, 2, pp. 65—6. London, 1954.
Correns, C. W. "Titan in Tiefsee-Sedimenten". Deep-Sea Res., **1**, 2, pp. 78—85. London, 1954.
Kolbe, R. W. "Über Süsswasser-Diatomeen in Atlantischen Tiefsee-Sedimenten". Deep-Sea Res., **1**, 2, pp. 95—7. London, 1954.
Landergren, S. "On the relative abundance of the stable carbon isotopes in marine sediments". Deep-Sea Res., **1**, 2, pp. 98—120. London, 1954.
Lees, G. M. "The geological history of the oceans". Deep-Sea Res., **1**, 2, pp. 67—71. London, 1954.
Linke, O. "Wandernde Küste". Natur u. Volk, **83**, 11, pp. 365—74. Frankfurt, 1953.
Nares, J. D. "Synopsis of future plans for the preparation of sheets of the General Bathymetric Chart of the oceans". Deep-Sea Res., **1**, 2, pp. 72—7. London, 1954.
Northrop, J. "A bathymetric profile across the Hudson Submarine Canyon and its tributaries". Journ. Mar. Res., **12**, 2, pp. 223—32. New Haven, Conn., 1953.
Stocks, T. "Schallweicher und schallharter Boden im Bereich des Stoller Grundes (Kieler Bucht) in Beziehung zur Geologie". Deutsch. Hydrogr. Zeitschr., **5**, 2—3, pp. 149—53. Hamburg, 1952.

3) Plankton.

3) a Apparatus and Methods.

Barnes, H. "A simple and inexpensive closing net". Mem. Ist. Ital. Idrobiol., 7, pp. 189—98. Pallanza, 1953.
Motoda, S. "New plankton samplers". Bull. Faculty Fish., Hokkaido Univ., **3**, 3, pp. 181—6. Hakodate, 1953.

3) b General.

Digby, P. S. B. "Plankton production in Scoresby Sound, East Greenland". Journ. Anim. Ecol., **22**, 2, pp. 289—322. Cambridge, 1953.
Mosby, H. "Oceanographical investigations at Weather Ship Station M". Univ. Bergen, Årbok 1953, Naturvid. Rk., 10. Bergen, 1954.
Saito, I., & Mishima, S. "Studies on detection of plankton by echo-sounder (or fish-finder) and selection of fishing station in a fishing ground. (Preliminary report). Detection of D. S. L. by echo-sounder". Bull. Faculty Fish., Hokkaido Univ., **3**, 4, pp. 269—72. Hakodate, 1953. (In Japanese, English summary).
Silva, E. de S., & Pinto, J. de S. "Estudo do ciclo sazonal do plâncton marinho da Guiné Portuguêsa". Bol. Cult. Guiné Portuguêsa, 25, pp. 131—55. Bissau 1952.

Tham, A. K. "A preliminary study of the physical, chemical and biological characteristics of Singapore Straits". Colonial Office, Fish. Publ., **1**, 4. London, 1953.
Williamson, D. I. "Distribution of plankton in the Irish Sea in 1949 and 1950". Proc. Trans. Liverpool Biol. Soc., **58**, pp. 1—46. Liverpool, 1952.
Yamazi, I. "Plankton investigation in inlet waters along the coast of Japan. 7. The plankton collected during the cruises to the new Yamato Bank in the Japan Sea". Publ. Seto Mar. Biol. Lab., **3**, 1, pp. 75—108. Sirahama, Wakayama-Ken, 1953.

3) c Phytoplankton.

Birkenes, E., & Braarud, T. "Phytoplankton in the Oslo Fjord during a *Coccolithus Huxleyi*-summer". Avhandl. Norske Vidensk. Akad. Oslo, 1, Mat.-Naturv. Klasse, 1952, 2. Oslo, 1952.
Kamptner, E. "Das mikroskopische Studium des Skelettes der Coccolithineen. Part 1". Mikroskopie, 7, pp. 232—43. Wien, 1952.
Komarovsky, B. "A comparative study of the phytoplankton of several fish ponds in relation to some of the essential chemical constituents of the water". Bull. Res. Counc. Israel, **2**, 4, pp. 379—410. Caesarea, 1953.
Krey, J. "Plankton- und Sestonuntersuchungen in der südwestlichen Nordsee auf der Fahrt der 'Gauss' Februar/März 1952". Ber. Deutsch. Wiss. Komm. f. Meeresf., N. F., **13**, 2, pp. 136—53. Stuttgart, 1953.
Margalef, R., & Duran, M. "Microplancton de Vigo, de octubre de 1951 a septiembre de 1952". Publ. Inst. Biol. Aplicada, **13**, pp. 5—78. Barcelona, 1953.
McCombie, A. M. M. "Factors influencing the growth of phytoplankton". Journ. Fish. Res. Bd. Canada, **10**, 5, pp. 253—82. Toronto, 1953.
Melchers, F. C. M. "*Biddulphia chinensis* Grev., as indicator of ocean currents". Comm. Bot. Mus. Hist. Nat. Montevideo, **2**, 26, pp. 1—14. Montevideo, 1952.
Pavillard, J. "Remarques systématiques sur quelques Péridiniens". Bull. Inst. Océanogr., 1022. Monaco, 1953.
Schmitz, W. "Quantitative Phytoplankton-Untersuchung mit Membranfiltern". Jahresber. Limnol. Flussstat., pp. 60—6. Freudenthal, 1950.
Subrahmanyan, R. "Note on handling diatoms for cytological and life-history studies". Microscope, Nov.-Dec. London, 1951.
Subrahmanyan, R. "Notes on growing diatoms in cultures". Microscope, Jan.-Feb. London, 1952.

3) d Zooplankton.

Anon. "Zooplankton volumes off the Pacific coast 1952". U. S. Dept. Int., Fish Wildl. Serv., Spec. Sci. Rep. Fish., 100. Washington, 1953.
Anraku, M. "Seasonal distribution of pelagic copepods at Oshoro Bay, west coast of Hokkaido". Bull. Faculty Fish., Hokkaido Univ., **3**, 3, pp. 187—92. Hakodate, 1953.
Barnes, H. "Considerazioni statistiche sulla distribuzione spaziale di alcuni organismi planctonici raccolti su un lungo percorso nel golfo della Clyde". Mem. Ist. Ital. Idrobiol., 7, pp. 109—27. Pallanza, 1953.
Borutskii, E. V. "A new species of Schizopera (Copepoda, Harpacticoida) from the Caspian Sea". Zool. Zhurn., **32**, 5, pp. 848—52. Moscow, 1953. (In Russian).
Bückmann, A. "Fischbrut und Evertebraten-Groszplankton auf der Fahrt der 'Gauss' im Februar/März 1952". Ber. Deutsch. Wiss. Komm. f. Meeresf., N. F., **13**, 2, pp. 154—74. Stuttgart, 1953.
Carvalho, J. de P. "Sôbre uma colecáo de Copopodos, náo parasiticos, da baia de Santos e suas adjácencias". Bol. Inst. Oceanogr., **3**, 1—2, pp. 131—83. Sáo Paulo, 1952.
Croce, N. D. "Variazioni dello zooplancton di superficie pescate a Punta del Mesco (La Spezia) tra il 15—10—49 ed il 30—3—51". Bull. Mus. Inst. Biol. Univ. Genova, **29**, 157, pp. 87—116. Genova, 1952.
Eliassen, E. "The energy-metabolism of *Artemia salina* in relation to body size, seasonal rhythms, and different salinities". Univ. Bergen, Årbok 1952, Naturv. Rk., 11. Bergen, 1952.
Filteau, G., & Tremblay, J. L. "Ecologie de *Calanus finmarchicus* dans la Baie des Chaleurs". Natural. Canad., **80**, 1—2, pp. 1—82. Quebec, 1953.
Fisher, L. R., Kon, S. K., & Thompson, S. Y. "Vitamin A and carotenoids in some Mediterranean crustacea with a note on the swarming of *Meganyctiphanes*". Bull. Inst. Océanogr., 1021. Monaco, 1953.
Furnestin, M.-L. "Contribution à l'étude morphologique, biologique et systématique de *Sagitta serratodentata* Krohn des eaux atlantiques du Maroc". Bull. Inst. Océanogr., 1025. Monaco, 1953.

Furnestin, M.-L. "Sur quelques chaetognathes d'Israël". Bull. Res. Counc. Israel, **2**, 4, pp. 411—4. Caesarea, 1953.
Furuhashi, K. "On the vertical distribution of animal plankton in the sea of Japan off San'in-District in summer of 1952". Publ. Seto Mar. Biol. Lab., **3**, 1, pp. 61—74. Sirahama, Wakayama-Ken, 1953. (In Japanese).
George, P. C. "A systematic account of the Chaetognatha of the Indian coastal waters, with observation on their seasonal fluctuations along the Malabar coast". Proc. Nation. Inst. Sci. India, **18**, 6, pp. 657—89. Calcutta, 1952.
Ghirardelli, E. "L'accoppiamento in *Spadella cephaloptera* Busch.". Publ. Staz. Zool. Napoli, **24**, 3, pp. 345—54. Napoli, 1953.
Gilet, R. "Métazoé de *Dorippe lanata* (Linné) et sa megalope". Vie et Milieu, **3**, 4, pp. 415—20. Paris, 1952.
Gundersen, K. R. "Zooplankton investigations in some fjords in western Norway during 1950—51". Fiskeridirekt. Skr., Ser. Havunders., **10**, 6. Bergen, 1953.
Habe, T., & Tokioka, T. "Droplets from the plankton net. 12. Record of *Recluzia montrouzieri* Brazier near Seto". Publ. Seto Mar. Biol. Lab., **3**, 1, pp. 57—9. Sirahama, Wakayama-Ken, 1953. (In Japanese).
Haneda, Y. "Observations on some marine luminous organisms of Hachijo Island, Japan". Rec. Oceanogr. Works Japan, N. S., **1**, 1, pp. 103—8. Tokyo, 1953.
Hollande, A., & Enjumet, M. "Contribution à l'étude biologique des Sphaerocollides (Radiolaires collodaires et Radiolaires polycyttaires) et de leurs parasites. Partie 1. *Thalassicollidae, Physematidae, Thalassophysidae*". Ann. Sci. Nat., Sér. 11, **15**, pp. 99—183. Paris, 1953.
Ito, T. "Studies on the morphological variation in natural populations of Calanoida-Copepod of Japanese inland waters". Journ. Faculty Fish., Pref. Univ. Mie, **1**, 3. pp. 271—400. Mie, 1953.
Kramp, P. L. "Hydromedusae". Brit. Mus. (Natur. Hist.), Great Barrier Reef Exped. 1928—29, Sci. Rep., **6**, 4. London, 1953.
Laursen, D. "The genus *Ianthina*". Carlsberg Found., Dana-Rep., 38, pp. 3—40. Copenhagen, 1953.
Motoda, S. "Observations on diurnal migration of plankton crustaceans, in Lakes Shikotsu, Hokkaido, and Tsugarujuni, Aomori, and some experiments on photo- and geotropism". Mem. Faculty Fish., Hokkaido Univ., **1**, 1. Hakodate, 1953. (In Japanese).
Rae, B. B. "The occurrence of lemon sole larvae in the Scottish plankton collections of 1929, 1930 and 1931". Scottish Home Dept., Mar. Res. 1953, 1. Edinburgh, 1953.
Sewell, R. B. S. "The pelagic Tunicata". British Mus. (Natur. Hist.), John Murray Exped. 1933—34, Sci. Rep., **10**, 1. London, 1953.
Tanaka, O. "The pelagic copepods of the Izu region". Rec. Oceanogr. Works Japan, N. S., **1**, 1, pp. 126—37. Tokyo, 1953.
Tokioka, T., & Habe, T. "Droplets from the plankton net. 11. A new type of *Littorina-capsula*". Publ. Seto Mar. Biol. Lab., **3**, 1, pp. 55—6. Sirahama, Wakayama-Ken, 1953. (In Japanese).
Wada, S. K. "Notes on the ecology of a plankton copepod, *Labidocera pavo* Giesbrecht". Rec. Oceanogr. Works Japan, N. S., **1**, 1, pp. 100—2. Tokyo, 1953.

4) Organic Production.

4) a General.

Burlew, J. S. (Edit.). "Algal culture from laboratory to pilot plant". Carnegie Inst. Washington, Publ. 600. Washington, 1953.

4) b Bacteria.

Bang, F. B., & Frost, J. L. "The toxic effect of a marine bacterium on *Limulus* and the formation of blood clots". Biol. Bull., **105**, 2, pp. 361—2. Lancaster, Pa., 1953.
Heldt, J. H. "Eaux rouges". Bull. Soc. Sci. Nat. Tunisie, **5**, 1—4, pp. 103—6. Tunis, 1952.
Kadota, H. "Studies on the biochemical activities of marine bacteria. 2. On the properties of agar-digesting enzyme of *Vibrio purpureus*". Mem. Coll. Agric. Kyoto Univ., 66 (Fish. Ser. 3), pp. 31—8. Kyoto, 1953. (In Japanese).
Macleod, R. A., Onofrey, E., & Norris, M. E. "Studies on the nutrition and metabolism of marine bacteria. 1. Isolation and identification of the micro-organisms and a preliminary survey of their nutritional requirements". Prog. Rep. Pacific Coast Stat., 96, pp. 11—4. Vancouver, 1953.

Osnitskaya, L. K. "Occurrence of putrefying and sulphur-, methane- and hydrogen-oxidizing bacteria on the bottom of Caspian Sea". Mikrobiol., **22**, 4, p. 399. Moscow, 1953. (In Russian).

Velankar, N. K. "Bacteriological study of seawater off the coast of Madras (Bay of Bengal)". Proc. Indian Acad. Sci., Sect. B., **42**, 2, pp. 80—6. Bangalore, 1950.

5) Bottom Fauna and Flora.

5) a Apparatus and Methods.

Cohen, M. J. "Oscillographic analysis of an invertebrate equilibrium organ". Biol. Bull., **105**, 2, p. 363. Lancaster, Pa., 1953.

Crisp, D. J., Jones, L. W. G., & Watson, W. "Use of X-ray stereoscopy for examining shipworm infestation *in vivo*". Nature, **172**, 4374, pp. 408—9. London, 1953.

Harvey, E. B. "A simplified electrical method of determining the sex of sea urchins and other marine animals". Biol. Bull., **105**, 2, p. 365. Lancaster, Pa., 1953.

Liahov, S. M., & Zhidkov, L. P. "The bottom-trap — a sampler for studying transport of bottom organisms in river currents". Zool. Zhurn., **32**, 5, pp. 1020—4. Moscow, 1953. (In Russian).

Loosanoff, V. L. "Tagging the 'untaggable' ". Prog. Fish-Culturist, **15**, 4, pp. 186—7. Washington, 1953.

Rao, C. S. P. "Acetocarmine as a nuclear stain in Rhodophyceae". Nature, **172**, 4391, p. 1197. London, 1953.

Tamura, T. "On a new bottom snapper". Bull. Faculty Fish., Hokkaido Univ., **3**, 4, pp. 240—2. Hakodate, 1953. (In Japanese, English summary).

5) b Systematics and Development.

Allgén, C. A. "Über einige meistens neue oder seltene freilebende Nematoden aus dem Gullmarfjord (Bohuslän, Westküste Schwedens)". Zool. Anz., **151**, 5—6, pp. 86—95. Leipzig, 1953.

Alvarez, R. Z. "Decápodos españoles. 7. Algo sobre Hippolytidae de las costas N. E. de España". Publ. Inst. Biol. Aplicada, **13**, pp. 103—9. Barcelona, 1953.

Carlgren, O. "Actiniaria". Rep. Swedish Deep-Sea Exped., **2**, Zool. 1, pp. 99—104. Göteborg, 1951.

Chapman, G. "Studies of the mesogloea of coelenterates. 1. Histology and chemical properties". Quart. Journ. Microscop. Sci., **94**, Pt. 2, pp. 155—76. Oxford & London, 1953.

Child, C. M. "Redox indicator patterns in relation to echinoderm exogastrulation. 1. Oxidation patterns". Biol. Bull., **105**, 1, pp. 62—79. Lancaster, Pa., 1953.

Clark, R. B. "*Lumbrinereis cluthensis*, n. sp. (Eunicidae), a new polychaete from the Firth of Clyde". Ann. Mag. Natur. Hist., 12 Ser., **6**, 72, pp. 945—9. London, 1953.

Crisp, D. J., & Knight-Jones, E. W., "The mechanism of aggregation in barnacle populations. A note on a recent contribution by Dr. H. Barnes". Journ. Anim. Ecol., **22**, 2, pp. 360—2. Cambridge, 1953.

Eliason, A. "Polychaeta". Rep. Swedish Deep-Sea Exped., **2**, Zool. 1, pp. 129—48. Göteborg, 1951.

Elliott, G. F. "Brachial development and evolution in terebratelloid brachiopods". Biol. Rev. Cambridge Phil. Soc., **28**, 3, pp. 261—79. Cambridge, 1953.

Fage, L. "Deux Pycnogonides nouveaux de la côte occidentale d'Afrique". Bull. Mus. Nation. d'Hist. Nat., 2e Sér., **25**, 4, pp. 376—82. Paris, 1953.

Fage, L. "Sur un Pycnogonide de l'expédition suédoise des Grand Fonds 1947—48". Rep. Swedish Deep-Sea Exped., **2**, Zool. 1, pp. 93—7. Göteborg, 1951.

Gerlach, S. A. "*Lauratonema* nov. gen., Vertreter einer neuen Familie mariner Nematoden aus dem Küstengrundwasser". Zool. Anz., **151**, 3—4, pp. 43—52. Leipzig, 1953.

Gilsen, T. "Crinoidea with a survey of the bathymetric distribution of the deep-sea crinoids". Rep. Swedish Deep-Sea Exped., **2**, Zool. 1, pp. 49—58. Göteborg, 1951.

Goldstein, L. "A study of the mechanism of activation and nuclear breakdown in the *Chaetopterus* egg". Biol. Bull., **105**, 1, pp. 87—102. Lancaster, Pa., 1953.

Gordon, I. "On the Puerulus stage of some spiny lobsters (Palinuridae)". Bull. Brit. Mus. (Natur. Hist.) Zool., **2**, 2. London, 1950.

Habe, T. "Fissurellidae in Japan (2)". Publ. Seto Mar. Biol. Lab., **3**, 1, pp. 33—50. Sirahama, Wakayama-Ken, 1953. (In Japanese).

Habe, T. "Xenophoridae, Columbariidae and Caecidae in Japan". Seto Mar. Biol. Lab., Contrib. 196. Sirahama, Wakayama-Ken, 1953.

Hagmeier, A., & Künne, C. "Die wirbellosen Boden- und Nektontiere". Handb. Seefisch. Nordeuropas, **1**, 5b, pp. 87—176. Stuttgart, 1951.

Huvé, P. "Biologie de l'hydraire *Hypsorphus quadratus* (Forbes) 1848 en Méditerranée occidentale". Bull. Inst. Océanogr., 1019. Monaco, 1953.
Huvé, P. "Révision des polypes campanulinides méditerranéens. 2 Pt. *Dipleuron gracilis* (Clarke) 1882, nouvel hydraire campanulinide européen". Vie et Milieu, **3**, 4, pp. 389—96. Paris, 1952.
Kramp, P. L. "Hydrozoa and Scyphozoa". Rep. Swedish Deep-Sea Exped., **2**, Zool. 1, pp. 119—26. Göteborg, 1951.
de Laubenfels, M. W. "A guide to the sponges of eastern North America". Spec. Publ. Mar. Lab., Univ. Miami. Coral Gables, 1953.
Madsen, F. J. "Ophiuroidea". Rep. Swedish Deep-Sea Exped., **2**, Zool. 1, pp. 105—17. Göteborg, 1951.
Moore, A. R. "Alteration of developmental patterns in *Patiria miniata* by means of trypsin". Journ. Exper. Zool., **123**, 3, pp. 561—9. Philadelphia, 1953.
Mortensen, T. "Echinoidea". Rep. Swedish Deep-Sea Exped., **2**, Zool. 1, pp. 45—8. Göteborg. 1951.
Osburn, R. C. "Bryozoa of the Pacific coast of America. Part 3, Cyclostomata, Ctenostomata, Entoprocta, and Addenda". Allan Hancock Pacific Exped., **14**, 3. Los Angeles, 1953.
Rancurel, P. "*Teredo petiti* Récluz: description de la coquille larvaire". Bull. Mus. Nation. d'Hist. Nat., 2e Sér., **25**, 4, pp. 410—3. Paris, 1953.
Serène, R. "Observations sur le *Gonodactylus strigatus* Hansen (Crustacé Stomatopode)". Bull. Soc. Zool. France, **74**, 4—5, pp. 225—31. Paris, 1949.
Silén, L. "Bryozoa". Rep. Swedish Deep-Sea Exped., **2**, Zool. 1, pp. 61—9. Göteborg, 1951.
Smith, F. G. W. "Atlantic reef corals. A handbook of the common reef and shallow-water corals of Bermuda, Florida, the West Indies and Brazil". Univ. Miami Press. Coral Gables, Florida, 1948.
Tebble, N. "On a new and aberrant marine annelid from Natal, South Africa". Ann. Mag. Natur. Hist., 12 Ser., **6**, 72, pp. 938—44. London, 1953.
Thomson, J. M. "The genera of oysters and the Australian species". Austral. Journ. Mar. Freshw. Res., **5**, 1, pp. 132—68. Melbourne, 1954.
Tokioka, T. "Contributions to Japanese ascidian fauna. 5. Ascidians collected near the Marine Biological Laboratory of Hirosima University in the Inland Sea (1)". Publ. Seto Mar. Biol. Lab., **3**, 1, pp. 1—25. Sirahama, Wakayama-Ken, 1953.
Tokioka, T. "Contributions to Japanese ascidian fauna. 6. Simple ascidians of the Museum of Hukui". Publ. Seto Mar. Biol. Lab., **3**, 1, pp. 27—32. Sirahama, Wakayama-Ken, 1953.
Trueman, E. R. "Observations on certain mechanical properties of the ligament of *Pecten*". Journ. Exper. Biol., **30**, 4, pp. 453—67. Cambridge, 1953.
Trueman, E. R. "The ligament of *Pecten*". Quart. Journ. Microscop. Sci., **94**, 2, pp. 193—202. Oxford & London, 1953.
Utinomi, H. "On two interesting species of epizoic barnacle *Acasta* from Japan". Mem. Coll. Sci., Univ. Kyoto, Ser. B., **20**, 2, Art. 2. Kyoto, 1953. (In Japanese).
Werner, B. "Beobachtungen über den Nahrungserwerb und die Metamorphose der Metatrochophora von *Chaetopterus variopedatus* Renier u. Claparède (Polychaeta sedentaria)". Helgoländer Wiss. Meeresunters., **4**, 3, pp. 225—38. List (Sylt), 1953.
Westblad, E. "Some new 'Alloeocoels' (Turbellaria) from the Scandinavian west coast". Univ. Bergen, Årbok 1952, Naturv. Rk. 7. Bergen, 1952.
Whitear, M. "The stomatogastric nervous system of *Arenicola*". Quart Journ. Microscop. Sci., **94**, Pt. 3, pp. 293—302. Oxford & London, 1953.
Yonge, C. M. "Form and habit in *Pinna carnea* Gmelin". Phil. Trans. Roy. Soc. London, Ser. B., **237**, 648. London, 1953.
Yonge, C. M. "Studies on Pacific coast mollusks. 4. Observations on *Siliqua patula* Dixon and on evolution within the Solenidae". Univ. Calif. Publ. Zool., **55**, 9. Berkeley & Los Angeles, 1952.
Yonge, C. M. "Studies on Pacific coast mollusks. 5. Structure and adaptation in *Entodesma saxicola* (Baird) and *Mytilimeria nuttallii* Conrad, with a discussion on evolution within the family Lysoniidae (Eulamellibranchia)". Univ. Calif. Publ. Zool., **55**, 10. Berkeley & Los Angeles, 1952.
Yonge, C. M. "Studies on Pacific coast mollusks. 6. A note on *Kella laperousii* (Deshayes)". Univ. Calif. Publ. Zool., **55**, 11. Berkeley & Los Angeles, 1952.
Yonge, C. M. "The mantle cavity in *Siphonaria alternata* Say". Proc. Malacolog. Soc., **29**, 5, pp. 190—9. London, 1952.
Yonge, C. M. "The monomyarian condition in the Lamellibranchia". Trans. Roy. Soc. Edinburgh, **62**, Pt. 2, 12. Edinburgh & London, 1953.

Yoshida, H. "Studies on larvae and young shells of industrial bivalves in Japan". Journ. Shimonoseki Coll. Fish., **3**, 1. Shimonoseki City, 1953. (In Japanese, English summary).

5) c Distribution and Ecology.

Allen, J. A. "Observations on the epifauna of the deep-sea muds of the Clyde Sea area, with special reference to *Chlamys septemradiata* (Müller)". Journ. Anim. Ecol., **22**, 2, pp. 240—60. Cambridge, 1953.

Barnes, H. "The effect of lowered salinity on some barnacle nauplii". Journ. Anim. Ecol., **22**, 2, pp. 328—30. Cambridge, 1953.

Belloc, G. "Catalogue des types de Polychètes du Musée Océanographique de Monaco". Bull. Inst. Océanogr., 1027. Monaco, 1953.

Bougis, P., & Gabis, V. "Observations écologiques sur les variétés vertes et rouges d'*Actinia equina* L.". Vie et Milieu, **3**, 4, pp. 448—50. Paris, 1952.

Bock, K. J. "Zur Ökologie der Ciliaten des marinen Sandgrundes der Kieler Bucht. II.". Kieler Meeresforsch., **9**, 2, pp. 252—56. Kiel, 1953.

Buchholz, H., & Schütz, L. "Zur Kenntnis der im Litoral der Kieler Förde vorkommenden Seepocken (Cirripedia Thoracica)". Kieler Meeresforsch., **9**, 2, pp. 285—7. Kiel, 1953.

Burdon-Jones, C. "Records of British Ptychoderidae". Nature, **172**, 4373, pp. 342—3. London, 1953.

Carlgren, O. "Actiniaria". Rep. Swedish Deep-Sea Exped., **2**, Zool. 1, pp. 99—104. Göteborg, 1951.

Crisp, D. J., Jones, L. W. G., & Watson, W. "Use of X-ray stereoscopy for examining shipworm infestation *in vivo*". Nature, **172**, 4374, pp. 408—9. London, 1953.

Crisp, D. J., & Southward, A. J. "Isolation of intertidal animals by sea barriers". Nature, **172**, 4370, pp. 208—9. London, 1953.

Dall, W., & Stephenson, W. "A bibliography of the marine invertebrates of Queensland". Univ. Queensland Papers, Dept. Zool., **1**, 2, pp. 21—49. Brisbane, 1953.

Day, J. H. "The polychaet fauna of South Africa. Part 2. Errant species from Cape shores and estuaries". Ann. Natal Mus., **12**, 3, pp. 397—441. Dorking, 1953.

Eliason, A. "Polychaeta". Rep. Swedish Deep-Sea Exped., **2**, Zool. 1, pp. 129—48. Göteborg, 1951.

Endean, R. "Queensland faunistic records. Part III. Echinodermata (excluding Crinoidea)" Univ. Queensland Papers, Dept. Zool., **1**, 3, pp. 51—60. Brisbane, 1953.

Fage, L. "Sur un Pycnogonide de l'Expedition suédoise des Grands Fonds 1947—48". Rep. Swedish Deep-Sea Exped., **2**, Zool. 1, pp. 93—7. Göteborg, 1951.

Fauvel, P. "Annélides polychètes des Iles Kerguélen recueillies par M. Patrice Paulian, en 1951". Bull. Inst. Océanogr., 1026. Monaco, 1953.

Fauvel, P. "Sur quelques annélides polychètes d'Océanie". Bull. Mus. Nation. d'Hist. Natur., 2e Sér., **25**, 2, pp. 173—5. Paris, 1953.

Galliford, A. L. "Notes on the fauna of shore pools near Red Rocks and Hilbre Point, Hoylake and a suggested definition of the term 'brackish water'". Proc. Liverpool Nat. Field Club, 1951, pp. 15—8. Liverpool, 1952.

Gerlach, S. A. "Nematoden aus dem Küstengrundwasser". Akad. Wiss. Liter. Mainz, Abhandl. Math. Naturw. Kl., Jahrg. 1952, 6. Mainz, 1952.

Gilsen, T. "Crinoidea with a survey of the bathymetric distribution of the deep-sea crinoids". Rep. Swedish Deep-Sea Exped., **2**, Zool. 1, pp. 49—58. Göteborg, 1951.

Hagmeier, A. "Beziehungen der Ernährung zur Verbreitung der Arten und der Gemeinschaften der Bodentiere". Handb. Seefisch. Nordeuropas, **1**, 5b, pp. 177—242. Stuttgart, 1951.

Hedgpeth, J. W. "An introduction to the zoogeography of the northwestern Gulf of Mexico with reference to the invertebrate fauna". Publ. Inst. Mar. Sci., **3**, 1, pp. 107—224. Port Aransas, Texas, 1953.

Jaeckel, S. "Über Scaphopoden der Nordsee (haupsächlich nach den 'Poseidon'-Fängen 1902—1912)". Kieler Meeresforsch., **9**, 2, pp. 293—9. Kiel, 1953.

Judges, E. C. "Occurrence of *Phoronis müleri* in the Irish Sea". Nature, **172**, 4374, p. 409. London, 1953.

Kramp, P. L. "Hydrozoa and Scyphozoa". Rep. Swedish Deep-Sea Exped., **2**, Zool. 1, pp. 119—26. Göteborg, 1951.

Lafon, M. "Recherches sur les sables côtiers de la Basse-Normandie et sur quelques conditions de leur peuplement zoologique". Ann. Inst. Océanogr., **28**, 3. Paris, 1953.

Lewis, J. R. "The ecology of rocky shores around Anglesey". Proc. Zool. Soc., **123**, 3, pp. 481—549. London, 1953.

MacDonald, R., & McMillan, N. F. "The natural history of Lough Foyle, North Ireland". Proc. Roy. Irish Acad., **54** (B), pp. 67—96. Dublin, 1951.

Madsen, F. J. "Ophiuroidea". Rep. Swedish Deep-Sea Exped., **2**, Zool. 1, pp. 105—17. Göteborg, 1951.
Maéda, H. "Studies on Yosa Naikai 2. Considerations upon the range of the stagnation and the influences by the river Noda and the open sea". Journ. Shimonoseki Coll. Fish., **3**, 2, pp. 133—40. Shimonoseki, 1953. (In Japanese, English summary).
Maéda, H. "Studies on Yosa-Naikai 3. Analytical investigations on the influence of the river Noda and the benthonic communities". Journ. Shimonoseki Coll. Fish., **3**, 2, pp. 141—9. Shimonoseki, 1953. (In Japanese, English summary).
May, V. "A key to the marine algae of New South Wales. Part 2. Melanophyceae (Phaeophyceae)". Proc. Linn. Soc. N. S. Wales, **64**, 1—2, pp. 191—215. Sydney, 1939.
Mohr, J. L. "The relationship of the areas of marine borer attack to pollution patterns in Los Angeles Long Beach harbours". Rep. Mar. Borer Conf., Miami Beach, Florida, pp. I-1—5. Coral Gables, 1953.
Mortensen, T. "Echinoidea". Rep. Swedish Deep-Sea Exped., **2**, Zool., 1, pp. 45—8. Göteborg, 1951.
Nikitin, V. N., & Turpaieva, E. P. "The possibility of population of the Azov Sea by benthic animals from the Black Sea". Dok. Akad. Nauk S. S. S. R., **90**, 5, p. 893. Moscow, 1953. (In Russian).
Osburn, R. C. "Bryozoa of the Pacific coast of America. Part 3. Cyclostomata, Ctenostomata, Entoprocta, and Addenda". Allan Hancock Pacific Exped., **14**, 3, Los Angeles, 1953.
Pax, F., & Müller, I. "Die Anthozoenfauna der Bucht von Kastela bei Split". Acta Adriatica, **5**, 1. Split, 1953.
Rees, W. J. "Records of hydroids and medusae taken at Herdla, Bergen in 1937". Univ. Bergen, Årbok 1952, Naturvit. rekke, 16. Bergen, 1952.
Silén, L. "Bryozoa". Rep. Swedish Deep-Sea Exped., **2**, Zool. 1, pp. 61—9. Göteborg, 1951.
Smith, J. E. "The maintenance and spread of sea-shore faunas". Advance. Sci., 38. London, 1953.
Smith, R. I. "The distribution of the polychaete *Neanthes lighti* in the Salinas river estuary, California, in relation to salinity, 1948—1952". Biol. Bull., **105**, 2, pp. 335—47. Lancaster, Pa., 1953.
Stephenson, W. "Faunistic Records from Queensland. Part 1. General introduction. Part II. Adult Stomatopoda (crustacea)". Univ. Queensland Papers Dept. Zool., **1**. 1. Brisbane, 1952.
Taki, I. "Molluscan fauna of Hachijojima. Preliminary report". Rec. Oceanogr. Works Japan, N. S., **1**, 1, pp. 124—5. Tokyo, 1953.
Vatova, A., & Faganelli, A. "Le valli salse da pesca del Polesine". Nova Thalass., **1**, 10. Venezia, 1951.
Yonge, C. M. "Bottom fauna of the sea". Research, 1, pp. 589—95. London, 1948.
Yonge, C. M. "The form of coral reefs". Endeavour, **10**, 39. London, 1951.
Ziegelmeier, E. "Kurze Mitteilung über zwei für die Deutsche Bucht neue Polychätenarten der Gattungen *Capitomastus* und *Goniada*". Helgoländer Wiss. Meeresunters., **4**, 3, pp. 255—9. List (Sylt), 1953.
Ziegelmeier, E. "Beobachtungen über die Bohrtätigkeit der Nabelschnecke *Lunatia nitida* Donovan". Kurze Mitt. fischereibiol. Abt. Max-Planck-Inst. Meeresbiol., 3, pp. 46—52. Wilhelmshaven, 1953.

5) d Physiology and Behaviour.

Allen, R. D. "Fertilization and artificial activation in the egg of the surf-clam, *Spisula solidissima*". Biol. Bull., **105**, 2, pp. 213—39. Lancaster, Pa., 1953.
Allgen, C. A. "Über einen Fall von Hermaphroditismus in der Gattung *Desmodora* de Man (Chromadoroidea, Nematodes)". Zool. Anz., **151**, 5—6, pp. 95—8. Leipzig, 1953.
Anderson, J. D., & Prosser, C. L. "Osmoregulating capacity in populations occurring in different salinities". Biol. Bull., **105**, 2, p. 369. Lancaster, Pa., 1953.
Anderson, J. M. "Structure and function in the pyloric caeca of *Asterias forbesi*". Biol. Bull., **105**, 1, pp. 47—61. Lancaster, Pa., 1953.
Ashikaga, C. "Biochemical studies on the pearl-oyster (*Pinctada martensi*). Part 2. On the changes of glycogen content during the process of preservation". Bull. Nippon Inst. Sci. Res. Pearls, 1, 11a. Kyoto, 1953. (In Japanese, English summary).
Ashikaga, C. "Biochemical studies on the pearl-oyster (*Pinctada martensi*). Part 3. On the glycogen content in relation to portions and to sexes". Bull. Nippon Inst. Sci. Res. Pearls, 1, 11b. Kyoto, 1953. (In Japanese, English summary).

Ashikaga, C. "Biochemical studies on the pearl-oyster (*Pinctada martensi*). Part 4. On the chemical composition of the various tissues and also of the meat of the different ages". Journ. Agric. Chem. Soc. Japan, **24**, 9, pp. 432—5. Tokyo, 1951. (In Japanese, English summary).

Ashikaga, C. "Biochemical studies on the pearl-oyster (*Pinctada martensi*). Part 5. On the seasonal variations of the contents of the unsaponifiable matter and sterol". Journ. Agric. Chem. Soc. Japan, **24**, 9, pp. 436—8. Tokyo, 1951. (In Japanese, English summary).

Bacq, Z. M., & Ghiretti, F. "Physiologie des glandes salivaires postérieures des Céphalopodes Octopodes isolées et perfusées *in vitro*". Publ. Staz. Zool. Napoli, **24**, 3, pp. 267—77. Napoli, 1953.

Baptist, J. P. "Record of a hermaphroditic horseshoe crab, *Limulus polyphemus* L.". Breviora, 14. Cambridge, Mass., 1953.

Barnes, H. "An effect of parasitism on *Balanus balanus* (L.) da Costa". Nature, **172**, 4368, p. 128. London, 1953.

Barnes, H. "Orientation and aggregation in *Balanus balanus* (L.) da Costa". Journ. Anim. Ecol., **22**, 1, pp. 141—48. Cambridge, 1953.

Barnes, H. "The effect of lowered salinity on some barnacle nauplii". Journ. Anim. Ecol., **22**, 2, pp. 328—30. Cambridge, 1953.

Bock, K. J., & Schlieper, C. "Über den Einfluss des Salzgehaltes im Meerwasser auf den Grundumsatz des Seesternes *Asterias rubens* L.". Kieler Meeresforsch., **9**, 2, pp. 201—12. Kiel, 1953.

Brien, P. "La pérennité somatique". Biol. Rev. Cambridge Phil. Soc., **28**, 3, pp. 308—49. Cambridge, 1953.

Brown, F. A., Bennett, M. F., & Sandeen, M. I. "Temperature independence of the frequency of the endogenous tidal rhythmicity of the fiddler crab, *Uca pugnax*". Biol. Bull., **105**, 2, p. 371. Lancaster, Pa., 1953.

Brown, F. A. Jr., Fingerman, M., Sandeen, M. I., & Webb, H. M. "Persistent diurnal and tidal rhythms of color change in the fiddler crab, *Uca pugnax*". Journ. Exper. Zool., **123**, 1, pp. 29—60. Philadelphia, 1953.

Brøndsted, H. V. "The ability to differentiate, and the size of regenerated cells, after repeated regeneration in *Spongilla lacustris*". Quart. Journ. Microscop. Sci., **94**, 2, pp. 177—84. Oxford & London, 1953.

Buddenbrock, W. V., & Moller-Racke, I. "Über den Lichtsinn von *Pecten*". Publ. Staz. Zool. Napoli, **24**, 2, pp. 217—45. Napoli, 1953.

Bulbring, E., Burn, J. H., & Shelley, H. J. "Acetylcholine and ciliary movement in the gill plates of *Mytilus edulis*". Proc. Roy. Soc., Ser. B., **141**, 905, pp. 445—66. London, 1953.

Carlisle, A. I. "Observations on the behaviour of *Dromia vulgaris* Milne Edwards with simple ascidians". Publ. Staz. Zool. Napoli, **24**, 2, pp. 142—51. Napoli, 1953.

Carlisle, D. B. "Studies on *Lysmata seticaudata* Risso (Crustacea Decapoda). 3 & 4". Publ. Staz. Zool. Napoli, **24**, 3, pp. 278—91. Napoli, 1953.

Carlisle, D. B. "Studies on *Lysmata seticaudata* Risso (Crustacea Decapoda). 5. The ovarian inhibiting hormone and the hormonal inhibition of sex-reversal". Publ. Staz. Zool. Napoli, **24**, 3, pp. 355—72. Napoli, 1953.

Carlisle, D. B. "Studies on *Lysmata seticaudata* Risso (Crustacea Decapoda). 6. Notes on the structure of the neurosecretory system of the eyestalk". Publ. Staz. Zool. Napoli, **24**, 3, pp. 434—46. Napoli, 1953.

Carlisle, D. B., & Knowles, F. G. W. "Neurohaemal organs in crustaceans". Nature, **172**, 4374, pp. 404—5. London, 1953.

Chapman, G. "Studies on the mesoglœa of coelenterates. 2. Physical properties". Journ. Exper. Biol., **30**, 3, pp. 440—51. Cambridge, 1953.

Crisp, D. J. "Changes in the orientation of barnacles of certain species in relation to water currents". Journ. Anim. Ecol., **22**, 2, pp. 331—43. Cambridge, 1953.

Ewer, R. F., & Fox, H. M. "The function of chlorocruorin". Publ. Staz. Zool. Napoli, **24**, 2, pp. 197—200. Napoli, 1953.

Fatt, P., & Katz, B. "Distributed 'end-plate potentials' of crustacean muscle fibres". Journ. Exper. Biol., **30**, 3, pp. 433—9. Cambridge, 1953.

Fisher, L. R., Kon, S. K., & Thompson, S. Y. "Vitamin A and carotenoids in some Mediterranean crustacea with a note on the swarming of *Meganyctiphanes*". Bull. Inst. Océanogr., 1021. Monaco, 1953.

Fox, D. L., Oppenheimer, C. H., & Kittredge, J. S. "Microfiltration in oceanographic research. II. Retention of colloidal micelles by adsorptive filters and by filter-feeding invertebrates; proportions of dispersed organic to dispersed inorganic matter and to organic solutes". Journ. Mar. Res., **12**, 2, pp. 233—43. Toronto, 1953.

Gilet, R. "Accouplement, ponte et première larve d'*Aphysiella vaillanti* (van Beneden et Robb)". **Vie et Milieu, 3**, 4, pp. 412—4. Paris, 1952.

Harvey, E. N. "Bioluminescence: evolution and comparative biochemistry". Federation Proc., **12**, 2, p. 597. Baltimore, 1953.

Hines, M. N. "Use of autotomized legs in determining the phases of the tidal rhythm in *Uca pugnax*". **Biol. Bull., 105**, 2, pp. 375—6. Lancaster, Pa., 1953.

Honjo, I. "Reizphysiologische Untersuchungen von *Pinctada martensi* (Dunker). I. Lichtreaktion". Bull. Nippon Inst. Sci. Res. Pearls, 1, 6. Kyoto, 1953. (In Japanese).

Irwin, M. C. "Sea urchins damage steel piling". Science, **118**, 3068, p. 307. Lancaster, Pa., 1953.

Kalckar, H. M., Strominger, J. L., & Gevirtz, N. R. "A study of an unidentified ultraviolet absorbing substance occurring in the tissues of marine animals". Biol. Bull., **105**, 2, p. 391. Lancaster, Pa., 1953.

Kerkut, G. A. "The forces exerted by the tube feet of the starfish during locomotion". Journ. Exper. Biol., **30**, 4, pp. 575—83. Cambridge, 1953.

Kinne, O. "Wird die Häutungsfolge der Amphipoden (*Gammarus zaddachi* Sexton *zaddachi* Spooner, *G. zaddachi salinus* Spooner und *G. duebeni* Lilljeb.) durch die lunare Periodizität beeinflusst?". Kieler Meeresforsch., **9**, 2, pp. 271—9. Kiel, 1953.

Knight-Jones, E. W. "Laboratory experiments on gregariousness during setting in *Balanus balanoides* and other barnacles". Journ. Exper. Biol., **30**, 4, pp. 584—98. Cambridge, 1953.

Kohn-Abrest, E. "Focus on the chemical toxicology of arsenic. Its presence in crustacea and molluscs". **Ann. Falsif., 44**, pp. 13—6. Paris, 1951.

Lane, C. E. "Respiration of *Teredo* larvae". Rep. Mar. Borer Conf., Miami Beach, Florida, 1952, pp. L-1—5. Coral Gables, 1953.

Lasker, R., & Lane, C. E. "The origin and distribution in *Teredo larvaria* Clapp". **Biol. Bull., 105**, 2, pp. 316—9. Lancaster, Pa., 1953.

de Laubenfels, M. "Life histories and longevity of Poritera". Vie et Milieu, **3**, 4, pp. 386—8. Paris, 1952.

Leone, C. A. "Preliminary observations on intraspecific variation of the levels of total protein in the sera of some decapod crustacea". Science, **118**, 3063, pp. 295—6. Lancaster, Pa., 1953.

Love, W. E. "The permeability of the erythrocyte-like cells of *Phascolosoma gouldii*". **Biol. Bull., 105**, 1, pp. 128—32. Lancaster, Pa., 1953.

Lowndes, A. G. "The densities of some common aquatic molluscs from Plymouth". **Ann. Mag. Natur. Hist., 12 Ser., 6**, 72, pp. 950—2. London, 1953.

Maroney, S. P., & Ronkin, R. R. "Cholinesterase and ciliary activity in the gill of *Mytilus*". **Biol. Bull., 105**, 2, p. 378. Lancaster, Pa., 1953.

Matsui, Y. "On the formation of pearls in the pearl oyster". The Venus: Japan. Journ. Malacol., **16**, 1—4, pp. 25—32. Kyoto, 1953. (In Japanese).

Maynard, D. M. "Integration in the cardiac ganglion of *Homarus*". Biol. Bull., **105**, 2, p. 367. Lancaster, Pa., 1953.

Mori, S. "Daily rhythmic activities of 'Martens' pearl-oysters (*Pinctada martensi* [Dunker])". Bull. Nippon Inst. Sci. Res. Pearls, 1, 3. Kyoto, 1953. (In Japanese, English summary).

Mori, S. "On the respiration of *Pinctada martensi* (Dunker) in the sea water of low oxygen tension. (A preliminary note)". Bull. Nippon Inst. Sci. Res. Pearls, 1, 4. Kyoto, 1953. (In Japanese).

Ojima, Y. "Histological studies of the mantle of pearl oyster (*Pinctada martensi* Dunker)". Cytologia, **17**, 2, pp. 134—43. Tokyo, 1952.

Ojima, Y. "Histological studies on the mantle of pearl oyster, *Pinctada martensi* Dunker. Microscopical observations on the glandular cells". Bull. Nippon Inst. Sci. Res. Pearls, 1, 9. Kyoto, 1953. (In Japanese, English summary).

Ojima, Y. "On the histological studies of mantle tissue in *Pinctada martensi*, especially on histochemical studies in calcium". Bull. Nippon Inst. Sci. Res. Pearls, 1, 8. Kyoto, 1953. (In Japanese).

Papi, F., & Oardi, L. "Richerche sull'orientamento di *Talitrus saltator* (Montagu) (Crustacea-Amphipoda). 2. Sui fattori che regolano la variazione dell'angolo di orientamento nel corso del giorno. L'orientamento di notte. L'orientamento diurno di altre popolazioni". Zeitschr. vergleich. Physiol., **35**, 6, pp. 490—518. Berlin, 1953.

Papi, L., & Papi, F. "Richerche sull'orientamento di *Talitrus saltator* (Montagu) (Crustacea-Amphipoda). 1. L'orientamento durante il giorno in una popolazione del litorale tirrenico". Zeitschr. vergleich. Physiol., **35**, 6, pp. 459—89. Berlin, 1953.

Parry, G. "Osmotic and ionic regulation in the isopod crustacean *Ligia oceanica*". Journ. Exper. Biol., **30**, 4, pp. 567—74. Cambridge, 1953.

Picken, L. E. R. "A note on the nematocysts of *Corynactis viridis*". Quart. Journ. Microscop. Sci., **94**, 3, pp. 203—27. Oxford & London, 1953.

Pilgrim, R. L. C. "Osmotic relations in molluscan contractile tissues. 1. Isolated ventricle strip preparations from lamellibranchs (*Mytilus edulis* L., *Ostrea edulis* L., *Anodonta cygnea* L.)". Journ. Exper. Biol., **30**, 3, pp. 297–317. Cambridge, 1953.

Pilgrim, R. L. C. "Osmotic relations in molluscan contractile tissues. 2. Isolated gill preparations from lamellibranchs (*Mytilus edulis* L., *Ostrea edulis* L., *Anodonta cygnea* L.)". Journ. Exper. Biol., **30**, 3, pp. 318–30. Cambridge, 1953.

Quayle, D. B. "Movements in *Venerupis (Paphia) pullastra* (Montagu)". Proc. Malacolog. Soc., **28**, 1, pp. 31—7. London, 1949.

Richards, A. P. "The use of chlorination and heat in the control of marine borers". Rep. Mar. Borer Conf. Miami Beach, Florida, 1952, pp. M-1—6. Coral Gables, 1953.

Robson, E. A. "Nematocysts of *Corynactis*: the activity of the filament during discharge". Quart. Journ. Microscop. Sci., **94**, 3, pp. 229–35. Oxford & London, 1953.

Rodewald, M. "Zur Winterfischerei bei Südgrönland". Fischwirtsch., **5**, 8, p. 191. Hamburg, 1953.

Ronkin, R. R. "Surface activity of hypobranchial mucus of Busycon: possible nutritive function of mucous substances". Biol. Bull., **105**, 2, p. 381. Lancaster, Pa., 1953.

Rothschild, Lord, & Barnes, H. "The inorganic constituents of the sea-urchin egg". Journ. Exper. Biol., **30**, 4, pp. 534—44. Cambridge, 1953.

Sandeen, M. I., Stephens, G. C., & Brown, F. A. "Persistent diurnal rhythms of O_2-consumption in the periwinkle, *Littorina littorea*, and the oyster drill, *Urosalpinx cinereus*". Biol. Bull., **105**, 2, pp. 381—2. Lancaster, Pa., 1953.

Schäfer, W. "Schwimmende Verfrachtung von Muschelklappen". Natur und Volk, **83**, 10, pp. 355—7. Frankfurt, 1953.

Scott, D. B. M. "Observations on the carbohydrate metabolism of the developing *Chaetopterus* egg". Biol. Bull., **105**, 2, p. 359. Lancaster, Pa., 1953.

Segal, E., Rao, K. P., & James, T. W. "Rate of activity as a function of intertidal height within populations of some littoral molluscs". Nature, **172**, 4389, pp. 1108—9. London, 1953.

Smith, O. R. "Notes on the ability of the horseshoe crab, *Limulus polyphemus*, to locate soft-shell clams, *Mya arenaria*". Ecology, **34**, 3, pp. 636—7. Durham, N. C., 1953.

Smith, O. R. "Observations on the rate of decay of soft-shell clams (*Mya arenaria*)". Ecology, **34**, 3, pp. 640—1. Durham, N. C., 1953.

Steinberg, M. S. "Studies on the mechanism of physiological dominance in *Tubularia*". Biol. Bull., **105**, 2, p. 360. Lancaster, Pa., 1953.

Tsujii, T. "Studies on the midgut gland in Invertebrata. III. Cytochemical reactions of some midgut-gland cells in snail, crab and clam". Rep. Faculty Fish., Pref. Univ. Mie, **1**, 2, pp. 121—7. Mie, 1952.

Werner, B. "Über den Nahrungserwerb der Calyptraeidae (Gastropoda Prosobranchia). Morphologie, Histologie und Funktion der am Nahrungserwerb beteiligten Organe". Helgoländer Wiss. Meeresunters., **4**, 3, pp. 260—315. List (Sylt), 1953.

Wiersma, C. A. G. "Neural transmission in invertebrates". Physiol. Rev., **33**, 3, pp. 326—55. Washington, 1953.

Yonge, C. M. "Mantle chambers and water circulation in the Tridacnidae (Mollusca)". Proc. Zool. Soc., **123**, 3, pp. 551—61. London, 1953.

Yonge, C. M. "Marine boring organisms". Research, 4, pp. 162—7. London, 1951.

Zacks, S. I., & Welsh, J. H. "Cholinesterase and lipase in the ameobocytes, intestinal epithelium and heart muscle of the quahog, *Venus mercenaria*". Biol. Bull., **105**, 1, pp. 200—11. Lancaster, Pa., 1953.

5) e Parasitic Forms.

Bergan, P. "A note on the ellobiopsid genus *Amallocystis* Fage". Univ. Bergen, Årbok 1952, Naturvit. rekke, 14. Bergen, 1952.

5) f Marine Plants.

Burrows, E. M., & Lodge, S. M. "Culture of *Fucus* hybrids". Nature, **172**, 4387, pp. 1009—10. London, 1953.

Beth, K. "Der Algenbewuchs an Helgoländer Seetonnen". Helgoländer Wiss. Meeresunters., **4**, 3, pp. 239—54. List (Sylt), 1953.

Cribb, A. B. "*Macrocystis pyrifera* (L.) Ag. in Tasmanian Waters". Austral. Journ. Mar. Freshw. Res., **5**, 1, pp. 1—34. Melbourne, 1954.

Ercegovic, A. "Sur les Cysto-Seira Adriatiques. Leur morphologie, écologie et évolution". Inst. Océanogr. Pêche., Fauna Flora Adriatica, **2**. Split, 1952.

Hasegawa, Y., & Fukuhara, E. "Ecological studies on *Iridophycus cornucopiae* (P. et R.) Setchell et Gardner. 2. On the dimension of spores". Bull. Hokkaido Region. Fish. Res. Lab., 9, pp. 67—74. Hokkaido, 1953. (In Japanese, English summary).
Haxo, F. T., & Clendenning, K. A. "Photosynthesis and phototaxis in *Ulva lactuca* gametes". Biol. Bull., **105**, 1, pp. 103—114. Lancaster, Pa., 1953.
Hoffmann, C. "Neufunde von Benthos Algen in der Kieler Bucht". Kieler Meeresforsch., **9**, 2, pp. 228—30. Kiel, 1953.
Jorde, I. "Some algae from the western coast of Norway". Univ. Bergen, Årbok 1952. Naturvit. rekke, 8. Bergen, 1952.
Kornmann, P. "Der Formenkreis von *Acinetospora crinita* (Carm.) nov. comb.". Helgoländer Wiss. Meeresunters., **4**, 3, pp. 205—24. List (Sylt), 1953.
Kerslake, J. "Occurrence of *Asparagopsis armata* Harv. on the coast of Devon". Nature, **172**, 4384, p. 874. London, 1953.
Kucknuck, P. "Ectocarpaceen-Studien 1. *Hecatonema, Chilionema, Compsonema*". Helgoländer Wiss. Meeresunters., **4**, 3, pp. 316—52. List (Sylt), 1953.
Matsudaira, C., & Iwashi, H. "On environmental characteristics of cultural grounds of a laver, *Porphyra tenera* Kjellman in Matsushima Bay". Tohoku Journ. Agric. Res., **3**, 2, pp. 277—91. Sendai, 1953.
Newton, L. M. "Marine algae". British Mus. (Natur. Hist.), John Murray Exped. 1933—34, Sci. Rep., **9**, 5. London, 1953.
Smith, G. M. "Marine algae of the Monterey Peninsula, California". Stanford Univ. Press. Palo Alto, Cal., 1944.
Takagi, M. "Chemical studies on marine algae. 7. Tyrosine and tryptophane contents in various species of marine algae". Bull. Faculty Fish., Hokkaido Univ., **4**, 1, pp. 86—91. Hakodate, 1953. (In Japanese, English summary).
Wood, E. J. F. "Reducing substances in Zostera". Nature, **172**, 4385, p. 916. London, 1953.
Yamada, Y., & Segawa, S. "On some new or noteworthy algae from Hachijo Island". Rec. Oceanogr. Works Japan, N. S., **1**, 1, pp. 109—14. Tokyo, 1953.

6) Fish.

6) a Systematics, Morphology and Development.

Abe, T. "Notes on the flying-fishes of Hachijo Island, with nomenclatorial remarks on the flying-fishes of the mainland of Japan and Hokkaido. 1. 'Tobi-uo', *Prognichthys agoo*". Rec. Oceanogr. Works Japan, N. S., **1**, 1, pp. 115—23. Tokyo, 1953.
Bauchot-Boutin, M. L. "Revision synoptique du genre *Serrivomer* (Anguilliformes)". Bull. Mus. Nation. d'Hist. Nat., 2e Sér., **25**, 4, pp. 365—7. Paris, 1953.
Blegvad, H., & Loppenthin, B. "Fishes from the Iranian Gulf". Danish Sci. Invest. Iran, Pt. 3. Einar Munksgaard, Copenhague, 1944.
Ben-Tuvia, A. "Mediterranean fishes of Israel". State Israel Min. Agric. Dept. Fish., Sea Fish. Res. Stat., Bull., 8, pp. 1—36. Caesarea, 1953.
Böhlke, J. "A catalogue of the type specimens of recent fishes in the Natural History Museum of Stanford University". Stanford Ichthyol. Bull., **5**, pp. 1—168. Stanford, Calif., 1953.
Böhlke, J. "Studies on fishes of the family Characidae. No. 4. A review of the genus *Microschemobrycon* with descriptions of two new species". Ann. Mag. Natur. Hist., 12 Ser., **6**, 71, pp. 841—9. London, 1953.
Böhlke, J., & Briggs, J. C. "The rare cirrhitid fish genus *Oxycirrhites* in American waters". Calif. Fish Game, **39**, 3, pp. 375—80. Sacramento, 1953.
Cabo, F. L. "Monografía de los centracántidos mediterráneos, con un estudio especial de la biometría, biología y anatomía de *Spicara smaris* (L.)". Bol. Inst. Español Oceanogr., 59. Madrid, 1953.
Carcalho, J. de P. "Notulas ictiologicas. 1. Sôbre um estádio post-larvar do Barbeiro — *Acanthurus hepatus* (L.)". Bol. Inst. Oceanogr., **3**, 1—2, pp. 115—7. São Paulo, 1952.
Clark, E., & Gohar, H. A. F. "The fishes of the Red Sea: Order Plectognathi". Publ. Mar. Biol. Stat. Ghardaqu (Red Sea), 8. Cairo, 1953.
Ege, V. "Paralepididae I. (*Paralepis* and *Lestidium*). Carlsberg Foundation, Dana-Rep., 40, pp. 3—184. Copenhagen, 1953.
Gosline, W. A. "Hawaiian shallow-water fishes of the family Brotulidae, with the description of a new genus and notes on Brotulid anatomy". Copeia, 4, pp. 215—25. Baltimore, 1953.
Gray, I. E. "The relation of body weight to body surface area in marine fishes". Biol. Bull., **105**, 2, pp. 285—7. Lancaster, Pa., 1953.

Gray, O. "An introduction to the study of the comparative anatomy of the labyrinth". Journ. Laryngol. Otology, **65**, 10, pp. 681—703. London, 1951.

Grey, M. "Fishes of the family Gempylidae, with records of *Nesiarchus* and *Epinnula* from the Western Atlantic and descriptions of two new subspecies of *Epinnula orientalis*". Copeia, 3, pp. 135—41. Baltimore, 1953.

Günther, K. "Das 'Wangenproblem' und das 'Problem des Wirkungswinkels der Mundöffnung' in der funktionellen Genese des Visceralcraniums der Teleosteer". Zool. Anz., **151**, 7—8, pp. 157—66. Leipzig, 1953.

Harder, W. "Zur postembryonalen Entwicklung des Darmes beim Hering (*Clupea harengus* L.)". Zeitschr. Anat. Entwicklungsgesch., **116**, pp. 379—98. Berlin, 1952.

Hubbs, C. L. "Geographic and systematic status of the fishes described by Kner and Steindachner in 1863 and 1865 from fresh waters in Panama and Ecuador". Copeia, 3, pp. 141—8 . Baltimore, 1953.

Hubbs, C. L. "Identification and relationships of the anchovy described from California as *Anchovia scitula*". Copeia, 3, pp. 193—4. Baltimore, 1953.

Lowndes, A. G. "The densities of some common Echinodermata from Plymouth". Ann. Mag. Natur. Hist., 12 Ser., **6**, 68, pp. 623—4. London, 1953.

Matsubara, K. "Revision of the Japanese Serranid fish, referable to the genus *Acropoma*". Mem. Coll. Agric. Kyoto Univ., 66, (Fish. Ser. 3), pp. 21—9. Kyoto, 1953. (In Japanese).

Matta, F. "Di un nuovo apparecchio per rilevamenti ittiometrici". Boll. Pesca, Piscicolt. Idrobiol., **8**, 1, pp. 135—8. Roma, 1953.

Mazzi, V. "Il corpo glomerulare del talamo degli Attinotterigi". Publ. Staz. Zool. Napoli, **24**, 3, pp. 373—433. Napoli, 1953.

Miura, T. "Morphological studies of the skipper, *Cololabis saira* (Brevoort) in the northern waters of Japan (1)". Bull. Faculty Fish., Hokkaido Univ., **3**, 4, pp. 225—32. Hakodate, 1953.

Munro, I. S. R. "Eggs and Larvae of the four-winged flying fish, *Hirundichthys speculiger* (Valenciennes)". Austral. Journ. Mar. Freshw. Res., **5**, 1, pp. 64—9. Melbourne, 1954.

Planas, A. "Un caso de teratodimia en la mielga (*Squalus acanthias* L.)". Publ. Inst. Biol. Aplicada, **13**, pp. 111—3. Barcelona, 1953.

Rosenthal, H. L. "Embryonic development of the lordotic and normal guppy, *Lebistes reticulatus* (Peters)". Biol. Bull., **105**, 1, pp. 160—5. Lancaster, Pa., 1953.

Scidmore, W. J., & Glass, A. W. "Use of pectoral fin rays to determine age of the white sucker". Prog. Fish-Culturist, **15**, 3, pp. 114—5. Washington, 1953.

Shanklin, D. R. "A rare poly-anomalous embryo". Biol. Bull., **105**, 2, pp. 382—3. Lancaster, Pa., 1953.

Shaver, J. R. "The development of isolated blastomeres of *Fundulus heteroclitus*" Biol. Bull., **105**, 2, p. 383. Lancaster, Pa., 1953.

Spartà, A. "Contributo alla conoscenza dello sviluppo larvale e giovanile di *Cyclothone signata* Garman (Sin. di *Cyclothone braueri* Tåning)". Boll. Pesca, Piscicolt. Idrobiol., **7**, 2, pp. 154—60. Roma, 1952.

Spartà, A. "Uova e larve di *Tetrapturus belone* Raf. (Aguglia Imperiale)". Boll. Pesca, Piscicolt. Idrobiol., **8**, 1, pp. 58—62. Roma, 1953.

Thomson, J. M. "The Mugilidae of Australia and adjacent seas". Austral. Journ. Mar. Freshw. Res., **5**, 1, pp. 70—131. Melbourne, 1954.

Yamamoto, T. O. "Artificially induced sex-reversal in genotypic males of the medaka (*Oryzias latipes*)". Journ. Exper. Zool., **123**, 3, pp. 571—94. Philadelphia, 1953.

6) b Distribution and Fluctuations.

Abe, T. "Records of the 'Mizu-uo-damashi' (new Japanese name), *Anotopterus pharao*, and a record of the 'Etchiopia', *Brama raii*, from near the surface of the north-western Pacific". Japan. Journ. Ichthyol., **2**, 4—5. Tokyo, 1953. (In Japanese).

Ahlstrom, E. H. "Pilchard eggs and larvae and other fish larvae, Pacific coast 1951". U. S. Dept. Int., Fish Wildl. Serv., Spec. Sci. Rep. Fish., 102. Washington, 1953.

Andreashev, A. K., & Panin, K. I. "The discovery of a Pacific sturgeon (*Acipenser medirostris* Ayres) in the Bering Sea". Zool. Zhurn., **32**, 5, pp. 932—6. Moscow, 1953. (In Russian).

Ben-Tuvia, A. "New Erythrean fishes from the Mediterranean coast of Israel". Nature, **172**, 4375, pp. 464—5. London, 1953.

Bückmann, A. "Fischbrut und Evertebraten-Grossplankton auf der Fahrt der 'Gauss' im Februar/März 1952". Ber. Deutsch. Wiss. Komm. Meeresf., N. F., **13**, 2, pp. 154—74. Stuttgart, 1953.

Dendy, J. S., & Scott, D. C. "Distribution, life history, and morphological variations of the southern brook lamprey, *Ichthyomyzon gagei*". Copeia, 3, pp. 152—62. Baltimore, 1953.
Fahy, W. E. "A fall record of the sand shark, *Carcharias taurus*, in North Carolina". Copeia, 4, pp. 239—40. Baltimore, 1953.
Fitch, J. E. "Extensions to known geographical distributions of some marine fishes on the Pacific coast". Calif. Fish Game, **39**, 4, pp. 539—52. Sacramento, 1953.
Fraser-Brunner, A. "Marine fish stocks of Somalia". F. A. O. Fish. Bull., **6**, 4, pp. 119—21. Rome, 1953.
Grainger, E. H. "On the age, growth, migration, reproductive potential and feeding habits of the Arctic char (*Salvelinus alpinus*) of Frobisher Bay, Baffin Island". Journ. Fish. Res. Board Canada, **10**, 6, pp. 326—70. Toronto, 1953.
Grey, M. "Fishes of the family Gempylidae, with records of *Nesiarchus* and *Epinnula* from the Western Atlantic and descriptions of two new subspecies of *Epinnula orientalis*". Copeia, 3, pp. 135—41. Baltimore, 1953.
Hora, S. L. "Fish distribution and Central Asian orography". Current Sci., **22**, 4, pp. 93—7. Bangalore, 1953.
Hoar, W. S. "Control and timing of fish migration". Biol. Rev. Cambridge Phil. Soc., **28**, 4, pp. 437—52. Cambridge, 1953.
Hubbs, C. L. "Geographic and systematic status of the fishes described by Kner and Steindachner in 1863 and 1865 from fresh waters in Panama and Ecuador". Copeia, 3, pp. 141—8. Baltimore, 1953.
Jackson, C. F. "Northward occurrence of southern fishes (*Fundulus, Mugil, Pomatomus*) in coastal waters af New Hampshire". Copeia, 3, p. 192. Baltimore, 1953.
Jackson, C. F. "Occurrence of the conger eel, *Conger oceanicus* (Mitchill), in the Gulf of Maine". Copeia, 4, pp. 237—8. Baltimore, 1953.
Karlovac, J. "Findings of bathypelagic fish species hitherto unknown in the Adriatic". Inst. Oceanogr. Ribarstvo, Biljeske, 2. Split, 1952.
Karlovac, O. "Occurrence of *Chimaera monstrosa* L. in the Adriatic". Inst. Oceanogr. Ribarstvo, Biljeske, 4. Split, 1953.
Kirincíc, J., & Lepetic, V. "Découverte de trois espèces de poissons, inconnus dans l'Adriatique". Inst. Oceanogr. Ribarstvo, Biljeske, 3. Split, 1953.
Kotthaus, A. "Drei seltene Haifische vom Rosengarten". Fischwirtsch., **5**, 8, pp. 196—7. Bremerhaven, 1953.
Krefft, G. "Ein weiterer seltener Fisch vom Rosengarten". Fischwirtsch., **5**, 11, p. 269. Bremerhaven, 1953.
Lafon, M. "Recherches sur les sables côtiers de la Basse-Normandie et sur quelques conditions de leur peuplement zoologique". Ann. Inst. Océanogr., **28**, 3. Paris, 1953.
Larraneta, M. G. "Sobre la distribución de los peces jóvenes bentónicos de las costas de Castellón". Publ. Inst. Biol. Aplicada, **14**, pp. 109—38. Barcelona, 1953.
Leapley, W. T. "First record of the ribbonfish, *Trachipterus trachyurus*, from the mainland of North America". Copeia, 4, p. 236. Baltimore, 1953.
Lunz, G. R. "First record of the marine fish *Centropomus undecimalis* in South Carolina". Copeia, 4, p. 240. Baltimore, 1953.
McKenzie, R. A. "Actic or polar cod, *Boreogadus saida*, in Miramichi Bay, New Brunswick". Copeia, 4, pp. 238—9. Baltimore, 1953.
Miller, R. R. "Second specimen of the eel *Gorgasia punctata*, an addition to the known fish fauna of Mexico". Copeia, 4, pp. 236—37. Baltimore, 1953.
Nair, R. V. "Studies on some fish eggs and larvae of the Madras plankton". Proc. Indian Acad. Sci., Sect. B, **35**, 5, pp. 181—208. Bangalore, 1952.
Nair, R. V. "Studies on some post-larval fishes of the Madras plankton". Proc. Indian Acad. Sci., Sect. B, **35**, 6, pp. 225—44. Bangalore, 1952.
Rae, B. B., & Wilson, E. "Rare and exotic fishes recorded in Scotland during 1951". Scot. Naturalist, **64**, pp. 102—11. Edinburgh, 1952.
Rodewald, M. "Eisberge als Fischbojen?". Die Fischwirtsch., **5**, 7, p. 169. Bremerhaven, 1953.
Sachlan, E. "Rarru-Klakah sebagai sumber perikanan". Berita Perikanan, Tahun ke 5, 1, pp. 3—5. Tjakarta, 1953. (English summary).
Saito, I., & Mishima, S. "On the migration of Pacific saury *Cololabis saira* (Brevoort) in Tsugaru-Strait (1)". Bull. Faculty Fish., Hokkaido Univ., **3**, 4, pp. 273—6. Hakodate, 1953. (In Japanese, English summary).
Scattergood, L. W., & Coffin, G. C. "Records of the black ruffe, *Centrolophus niger*, and the mackerel scad, *Decapterus macarellus*, in the Gulf of Maine". Copeia, 4, p. 237. Baltimore, 1953.
Scattergood, L. W. "Notes of Gulf of Maine fishes in 1952". Copeia, 3, pp. 194—5. Baltimore, 1953.

Seilacher, A. "Rotfeuerfische". Natur u. Volk, **83**, 11, pp. 388—90. Frankfurt, 1953.
Seversmith, H. F. "Distribution, morphology and life history of *Lampetra aepyptera*, a brook lamprey, in Maryland". Copeia, 4, pp. 225—32. Baltimore, 1953.
Smith, J. L. B. "The fishes of the family Pseudogrammidae from East Africa". Ann. Mag. Natur. Hist., 12 Ser., **6**, 67, pp. 548—60. London, 1953.
Srivatsa, K. R. "Catches of a Japanese trawler in Saurashtra waters". Rec. Oceanogr. Works Japan, N. S. **1**, 1, pp. 149—54. Tokyo, 1953.
Tham, A. K. "A preliminary study of the physical, chemical and biological characteristics of Singapore Straits". Colonial Office, Fish. Publ., **1**, 4. London, 1953.

6) c Physiology and Behaviour.

Arnold, D. C. "Observations on *Carapus acus* (Brunnich). (Jugulares, Carapidae)". Publ. Staz. Zool. Napoli, **24**, 2, pp. 152—66. Napoli, 1953.
Atz, E. H. "Experimental differentiation of basophil cell types in the transitional lobe of the pituitary of a teleost fish, *Astyanax mexicanus*". Bull. Bingham Oceanogr. Collect., Peabody Mus. Natur. Hist., Yale Univ., **14**, 2, pp. 94—116. New Haven, Conn., 1953.
Aughtry, R. H. "A note on mass mortality of the myctophid fish *Tarletonbeania crenularis*". Copeia, 3, pp. 190—2. Baltimore, 1953.
Barnes, L. J. "A further study of the effects of centrifugation and low temperature on the development of *Fundulus heteroclitus*". Biol. Bull., **105**, 2, p. 370. Lancaster, Pa., 1953.
Burner, C. J., & Moore, H. L. "Attempts to guide small fish with underwater sound". U. S. Dept. Int., Fish Wildl. Serv., Spec. Sci. Rep. Fish., 111. Washington, 1953.
Chambers, H. A. "Toxic effects of thiourea on the liver of the adult male killfish, *Fundulus heteroclitus* (Linn.)". Bull. Bingham Oceanogr. Collect., Peabody Mus. Natur. Hist., Yale Univ., **14**, 2, pp. 69—93. New Haven, Conn., 1953.
Collins, G. B. "Factors influencing the orientation of migrating anadromous fishes". U. S. Dept. Int., Fish Wildl. Serv., Fish Bull., **52**, 73. Washington, 1952.
Couillard, P. "An antimitotic substance in the ovary of the common puffer, *Sphaeroides maculatus*". Biol. Bull., **105**, 2, p. 372. Lancaster, Pa., 1953.
Doudoroff, P., Katz, M., & Tarzwell, C. M. "The toxicity of some new organic insecticides to fish". Federal Sec. Agency, Public Health Serv., Environmental Health Centre, Activity Rep., 7, pp. 13—7. Cincinnati, 1951.
Fratini, L. "Osservazioni sulla spermatogenesi di *Scylliorrhinus canicula*". Publ. Staz. Zool. Napoli, **24**, 2, pp. 201—6. Napoli, 1953.
Furukawa, A., & Ogasawara, Y. "Studies on nutrition of fish. 3. Digestibility of protein in dried, and fat-free dried silkworm pupa and fish-meal". Bull. Nakai Region. Fish. Res. Lab., 5, pp. 25—9. Ujina Hiroshima, 1953. (In Japanese).
Furukawa, A., Ogasawara, Y., & Hashiguchi, T. "Studies on nutrition of fish. 4. Digestibility of protein in artificial and several natural diets". Bull. Nakai Region. Fish. Res. Lab., 5, pp. 31—6. Ujina Hiroshima, 1953. (In Japanese).
Green, J. W., & Hoffman, J. F. "A study of isotonic solutions for the erythrocytes of some marine teleosts and elasmobranchs". Biol. Bull., **105**, 2, pp. 289—95. Lancaster, Pa., 1953.
Greenwood, P. H. "Feeding mechanism of the Cichlid fish, *Tilapia esculenta* Graham". Nature, **172**, 4370, pp. 207—8. London, 1953.
Gunter, G. "Observations on fish turning flips over a line". Copeia, 3, pp. 188—90. Baltimore, 1953.
Haempel, O. "Der Einfluss von Hormonen auf das Wachstum und die Geschlechtsreife bei Fischen". Arch. f. Hydrobiol., **48**, 1, pp. 97—104. Stuttgart, 1953.
Hamer, D. "Oxidation of amino acids by marine animals". Biol. Bull., **105**, 2, p. 390. Lancaster, Pa., 1953.
Harvey, E. N. "Bioluminescence: evolution and comparative biochemistry". Federation Proc., **12**, 2, p. 597. Baltimore, 1953.
Hashimoto, Y. "Effect of antibiotics and vitamin B_{12} supplement on carp growth". Bull. Japan. Soc. Sci. Fish., **19**, 8, pp. 899—904. Tokyo, 1953. (In Japanese, English summary).
Hasler, A. D. "Odour perception and orientation in fishes". Journ. Fish. Res. Board Canada, **11**, 2, pp. 107—29. Toronto, 1954.
Hatanaka, M., Watanabe, T., Sekino, K., & Kosaka, M. "Studies on the reproduction of the saury, *Cololabis saira* (Brevoort), of the Pacific coast of Japan". Tohoku Journ. Agric. Res., **3**, 2, pp. 293—302. Sendai, 1953. (In Japanese).
Heilbrunn, L. V., Wilson, W. L., & Lippman, M. "Antimitotic substances present in ovaries". Biol. Bull., **105**, 2, p. 375. Lancaster, Pa., 1953.

Hiatt, R. W., Naughton, J. J., & Matthews, D. C. "Relation of chemical structure to irritant responses in marine fish". Nature, **172**, 4385, pp. 901—5. London, 1953.

Higashi, H., Kaneko, T., & Sugii, K. "Studies on utilization of the liver oil of deep sea sharks. IV. Hydrocarbon contents in 'Yumezame', *Centroscymnus owsioni* Garman". Bull. Japan. Soc. Sci. Fish., **19**, 7, pp. 836—50. Tokyo, 1953. (In Japanese, English summary).

Higashi, H., Kaneko, T., & Sugii, K. "Studies on utilization of the liver oil of deep sea sharks. V. Hydrocarbon contents in 'Heratsunozame' *Deania* spp.". Bull. Japan. Soc. Sci. Fish., **19**, 7, pp. 851—61. Tokyo, 1953. (In Japanese, English summary).

Higashi, H., Kaneko, T., & Sugii, K. "Studies on utilization of the liver oil of deep sea sharks. VI. Hydrocarbon contents in the liver oil of the 'Aizame' *Centrophorus* spp". Bull. Japan. Soc. Sci. Fish., **19**, 7, pp. 862—70. Tokyo, 1953. (In Japanese, English summary).

Huntsman, A. G. "Ausrichtung der Fische durch die Strömung und ihre Bedeutung für den Fang (von Meeresfischen)". Fischwirtch., **5**, 6, pp. 144—6. Bremerhaven, 1953.

Kawamoto, N. Y., & Kobayashi, H. "Influence of various light conditions on the gathering rates of fish". Rep. Faculty Fish., Pref. Univ. Mie, **1**, 2, pp. 139—50. Mie, 1952.

Kawamoto, N. Y., & Konishi, J. "The correlation between wave length and radiant energy affecting phototaxis". Rep. Faculty Fish., Pref. Univ. Mie, **1**, 2, pp. 197—208. Mie, 1952.

Kawamoto, N. Y., & Nagata, S. "On the relation between light gradient and fish behaviour". Rep. Faculty Fish., Pref. Univ. Mie, **1**, 2, pp. 151—73. Mie, 1952.

Kawamoto, N. Y., & Niki, T. "An experimental study on the effect of leading fish by fish attraction lamps". Rep. Faculty Fish., Pref. Univ. Mie, **1**, 2, pp. 175—96. Mie, 1952.

Kleerekoper, H., & Chagnon, E. C. "Hearing in fish, with special reference to *Semotilus atromaculatus atromaculatus* (Mitchill)". Journ. Fish. Res. Board Canada, **11**, 2, pp. 130—52. Toronto, 1954.

Lovelace, F. E., & Podoliak, H. A. "Absorption of radioactive calcium by brook trout". Prog. Fish-Culturist, **14**, 4, pp. 154—58. Washington, 1952.

Lovern, J. A., & Olley, J. "The lipids of fish. 4. The lipids extracted by an ethanol: ether mixture from haddock flesh previously extracted with acetone". Biochem. Journ., **55**, 4, pp. 686—96. Cambridge, 1953.

Lowenstein, O. "Effect of galvanic polarization on the impulse discharge from the horizontal ampulla of the isolated elasmobranch labyrinth". Nature, **172**, 4377, pp. 549—50. London, 1953.

Lowenstein, O., & Roberts, T. D. M. "The equilibrium function of the otolith organs of the thornback ray (*Raja clavata*)". Journ. Physiol., **110**, 3—4, pp. 392—415. London & Cambridge, 1949.

Lowenstein, O., & Roberts, T. D. M. "The localization and analysis of the responses to vibration from the isolated elasmobranch labyrinth. A contribution to the problem of the evolution of hearing in vertebrates". Journ. Physiol., **114**, 4, pp. 471—89. London & Cambridge, 1951.

Maiskii, V. N. "On types of spawning populations of fishes". Zool. Zhurn., **32**, 5, pp. 920—22. Moscow, 1953. (In Russian).

Nietzke, G. "Herbizide Hormon-Präparate und ihre Wirkung auf Fische". Arch. f. Fischereiwiss., 1952—53, pp. 36—9. Braunschweig, 1952.

Nusenbaum, L. M. "Forms of erythrocytes in fishes". Dok. Akad. Nauk S. S. S. R., **90**, 5, p. 889. Moscow, 1953. (In Russian).

Ozaki, H. "Sur la phototaxie des poissons isolés". Rep. Faculty Fish., Pref. Univ. Mie, **1**, 2, pp. 129—38. Mie, 1952.

Palay, S. L. "A note on the effects of hypophysectomy on the preoptico-hypophysial pathway in *Fundulus*". Bull. Bingham Oceanogr. Collect., Peabody Mus. Natur. Hist., Yale Univ., **14**, 2, pp. 42—45. New Haven, Conn., 1953.

Pickford, G. E. "A study of the hypophysectomized male killifish, *Fundulus heteroclitus* (Linn.)". Bull. Bingham Oceanogr. Collect., Peabody Mus. Natur. Hist., Yale Univ., **14**, 2, pp. 5—41. New Haven, Conn., 1953.

Pickford, G. E. "The response of hypophysectomized male *Fundulus* to injections of purified beef growth hormone". Bull. Bingham Oceanogr. Collect., Peabody Mus. Natur Hist., Yale Univ., **14**, 2, pp. 46—68. New Haven, Conn., 1953.

Saunders, R. L. "The swimbladder gas content of some freshwater fish with particular reference to the physostomes". Canadian Journ. Zool., 31, pp. 547—60. Ottawa, 1953.

Schmeing-Engberding, F. "Die Vorzugstemperaturen einiger Knochenfische und ihre physiologische Bedeutung". Zeitschr. Fisch. u. d. Hilfswiss., **2**, N. F., 1—2, pp. 125—55. Radebeul & Berlin, 1953.

Shanklin, D. R. "Cation interrelationships at the *Fundulus* ectoderm". Biol. Bull., **105**, 2, p. 368. Lancaster, Pa., 1953.

Shepherd, D. M., West, G. B., & Erspamer, V. "Chromaffin bodies of various species of dogfish". Nature, **172**, 4376, p. 509. London, 1953.

Smith, C. G., Lewis, W. M., & Kaplan, H. M. "A comparative morphologic and physiologic study of fish blood". Prog. Fish-Culturist, **14**, 4, pp. 169—72. Washington, 1952.

Stokely, P. S., & Dineen, C. F. "Analysis of growth in the central mudminnow, *Umbra limi*". Copeia, 4, pp. 232—34. Baltimore, 1953.

Stuart, T. A. "Water currents through permeable gravels and their significance to spawning salmonids, etc.". Nature, **172**, 4374, pp. 407—8. London, 1953.

Sullivan, C. M. "Temperature reception and responses in fish". Journ. Fish. Res. Board Canada, **11**, 2, pp. 153—70. Toronto, 1954.

Swingle, H. S., Prather, E. E., & Lawrence, J. M. "Partial poisoning of overcrowded fish populations". Alabama Polytechn. Inst., Agric. Exper. Stat., Circ. 113. Auburn, Alabama, 1953.

6) d Parasites and Diseases.

Causey, D. "Parasitic Copepoda of Texas coastal fishes". Publ. Inst. Mar. Sci., **3**, 1, pp. 5—16. Port Aransas, Texas, 1953.

Euzet, L. "Recherches sur les Cestodes Tétraphyllides". Vie et Milieu, **3**, 4, pp. 397—411. Paris, 1952.

Heldt, J. H. "Notes sur quelques petits Crustacés ichthyophages". Bull. Soc. Sci. Nat. Tunisie, **5**, 1—4, pp. 111—3. Tunis, 1952.

Heldt, J. H. "Note sur un mâle de *Pennella* (Copépode parasite)". Bull. Soc. Sci. Nat. Tunisie, **5**, 1—4, pp. 169—70. Tunis, 1952.

Herzog, P. "Der Kalzium- und Phosphorgehalt des Blutes bauchwassersuchtkranker Karpfen". Arch. f. Fischereiwiss., 1952—53, pp. 144—9. Braunschweig, 1953.

Johnson, H. E., & Brice, R. F. "Further observations on columnaris in salmon and trout". Prog. Fish-Culturist, **15**, 4, pp. 183—5. Washington, 1953.

Mann, H. "*Lernaeocera branchialis* (Copepoda parasitica) und seine Schadwirkung bei einigen Gadiden". Arch. f. Fischereiwiss., 1952—53, pp. 133—44. Braunschweig, 1953.

Roegner-Aust, S., & Deubner, B. "Weitere Untersuchungen über die Pockenkrankheit des Karpfens". Zeitschr. f. Naturforsch., 7b, 572. Wiesbaden, 1952.

Roegner-Aust, & Schleich, F. "Zur Aetiologie einiger Fischkrankheiten". Zeitschr. f. Naturforsch., 6b, 448. Wiesbaden, 1951.

Rucker, R. R., & Gustafson, P. V. "An epizootic among rainbow trout". Prog. Fish-Culturist, **15**, 4, pp. 179—81. Washington, 1953.

Rucker, R. R., Whipple, W. J., Parvin, J. R., & Evans, C. A. "A contagious disease of salmon possibly of virus origin". U. S. Dept. Int., Fish Wildl. Serv., Fish. Bull., **54**, 76. Washington, 1953.

Schäperclaus, W. "Die Blumenkohlkrankheit der Aale und andere Fische der Ostsee". Zeitschr. Fisch. u. d. Hilfswiss., **2**, N. F., 1—2, pp. 105—24. Radebeul & Berlin, 1953.

Yamaguti, S., & Utinomi, H. "*Lernaeenicus quadrilobatus* n. sp. (Copepoda, Lernaeidae) parasitic on the lantern-fish *Diaphus coeruleus*". Publ. Seto Mar. Biol. Lab., **3**, 1, pp. 51—3. Sirahama, Wakayama-Ken, 1953. (In Japanese).

7) Marine Fisheries.

7) a Commercial Fisheries: Statistical.

Anderson, A. W., & Peterson, C. E. "Fishery statistics of the United States 1949". U. S. Dept. Int. Fish Wildl. Serv., Statist. Digest. 25. Washington, 1952.

Anderson, A. W., & Power, E. A. "Fishery statistics of the United States 1947". U. S. Dept. Int., Fish Wildl. Serv., Statist. Digest. 21. Washington, 1950.

Anderson, A. W., & Power, E. A. "Fishery statistics of the United States 1948". U. S. Dept. Int., Fish Wildl. Serv., Statist. Digest. 22. Washington, 1951.

Anon. "Maandstatistiek van de visserij". Centr. Bur. Statist. Utrecht.

Anon. "Statistiek van de visserij 1952". Centr. Bur. Statist. Utrecht, 1953.

Anon. "France: Statistiques des régions de pêche". Rev. Trav. Off. Pêches Marit., **16**, 1—4, pp. 145—57. Paris, 1951.

Anon. "Jaarcijfers over de visserij gedurende het jaar 1952". Versl. Meded. Direct. Visserij, 44. 's-Gravenhage, 1953.
Anon. "Jahresbericht über die deutsche Fischerei 1952". Berlin, 1953.
Anon. "Report by the Chief Secretary on the fisheries in New South Wales for the year ended 30th June, 1952". Parliament of New South Wales. Sidney, 1953.
Anon. "Sea fisheries statistical tables 1952". Min. Agric. Fish. London, 1953.
Anon. "Some details about Norway's fisheries". Internat. Fish. Journ., 1, pp. 11—3. Copenhagen, 1953.
Anon. "Statistica della pesca e della caocia negli anni 1949 e 1950". Ist. Centr. Statist. Roma, 1952.
Anon. "Statistical report of fresh and canned fishery products — year 1952 — sardine season, 1952—53". State Calif., Dept. Fish Game, Circ. 27. Sacramento, 1953.
Anon. "The Danish fishery". Internat. Fish. Journ., 1, pp. 5—9. Copenhagen, 1953.
Hass, G. "Entwicklung der Dampfer-Heringsfischerei in der ersten Jahreshälfte". Fischwirtsch., **5**, 10, pp. 235—6. Bremerhaven, 1953.
Rosén, N. "Die schwedische Westküstenfischerei". Handb. Seefisch. Nordeuropas, **8**, 3a. Stuttgart, 1953.
Thompson, S. H. "Alaska fishery and fur-seal industries: 1948". U. S. Dept. Int., Fish Wildl. Serv., Statist. Digest, 23. Washington, 1952.
Thompson, S. H. "Alaska fishery and fur-seal industries: 1949". U. S. Dept. Int., Fish Wildl. Serv., Statist. Digest, 23. Washington, 1952.
Viksø, H. "Vintersildfisket 1952. (Stor- og vårsildfisket)". Årsber. vedk. Norges Fisk., 1952, 2. Bergen, 1953.
Witje, J. A. P. "De visserij in 1952". Visserij-Nieuws, **6**, 7, pp. 100—4. 's-Gravenhage, 1953.

7) b Fish Technology.

Amano, K., & Bito, M. "Consequence of free amino acids generated from decomposing fish muscle". Bull. Tokai Region Fish. Res. Lab., **6**, 83. Tokyo, 1953. (In Japanese, English summary).
Boyd, J., Brumwell, C., & Tarr, H. L. A. "Aureomycin in experimental fish preservation". Prog. Rep. Pacific Coast Stat., 96, pp. 25—8. Vancouver, 1953.
Castell, C. H. "Cool storage of lightly salted fish in kench and under pickle". Prog. Rep. Atlantic Coast Stat., 56, pp. 17—22. St. Andrews, N. B., 1953.
Castell, C. H. "Improving the effectiveness of nitrite dips". Prog. Rep. Atlantic Coast Stat., 56, pp. 14—17. St. Andrews, N. B., 1953.
Cutting, C. L. "Notes on the preparation of smoked salmon". Dept. Sci. Indust. Res., Food Invest., Advisory Note, 10. London, 1953.
Dewberry, E. B. "The dressing, curing and smoking of salmon". Food Manufacture, **28**, 11, pp. 425—7. London, 1953.
Drilhon, A. "Répartition des acides aminés libres et des substances fluorescentes dans les autolysats des tissus de poissons". Bull. Inst. Océanogr., 1028. Monaco, 1953.
Le Gall, J. "Le poisson et le froid". Rev. Trav. Off. Pêches Marit., **16**, 1—4. Paris, 1951.
Heen, E. "Årsmelding 1952 fra Fiskeridirektoratets Kjemisk-Tekniske Forskningsinstitutt". Årsber. vedk. Norges Fisk. 1952, 7. Bergen, 1953.
Kawabata, T. "Histological and histochemical studies on fish muscle. 1. Histological changes in the muscle fibers of Albacore. (Studies on tunny meat — 11)". Bull. Japan. Soc. Sci. Fish., **19**, 7, pp. 813—8. Tokyo, 1953. (In Japanese, English summary).
Legendre, R. "How to determine if atmospheric conditions are favourable for the artificial drying of salted codfish". Prog. Rep. Atlantic Coast Stat., 56, pp. 23—4. St. Andrews, N. B., 1953.
Norris, E. R., & Mathies, J. C. "Preparation, properties and crystallization of tuna pepsin". Journ. Biol. Chem., **204**, 2, pp. 673—80. Baltimore, 1953.
Shewan, J. M., MacIntosh, R. G., Tucker, C. G., & Ehrenberg, A. S. C. "The development of a numerical scoring system for the sensory assessment of the spoilage of wet white fish stored in ice". Journ. Sci. Food & Agric., 6, pp. 283—98. London, 1953.

7) c Fishing Vessels and Gear.

Anon. "Bedeutung der Netzfarbe". Fischwirtsch., **5**, 11, p. 266. Bremerhaven, 1953.
Anon. "Encore des casiers démontables. (1). Le casier à crabe Stephenson". Pêche Marit., 907, p. 452. Paris, 1953.
Anon. "'Fairtry' — world's largest trawler". World Fishing, **2**, 9, pp. 353—8. London, 1953.

Anon. "Fish location with new equipment". Internat. Fish Journ., 1, pp. 26—7. Copenhagen, 1953.
Anon. "Improved night baiting net". Fish. Newsletter, **12**, 8, p. 2. Sydney, 1953.
Anon. "La pêche aux poissons volants". Bull. Soc. Études Indo-Chin., N. S., **27**, 1, pp. 15—23. Saigon, 1952.
Anon. "Maryland's soft-shell clam fishery developing fast". Comm. Fish. Rev., **15**, 6, pp. 22—3. Washington, 1953.
Anon. "Special research work planned for the 'Sarsia'". Fishing News, 2118, p. 3. London, 1953.
Anon. "Summaries of papers read at F. A. O. congress. Session on 'Fishing Boat Types'". World Fishing, **2**, 11, pp. 429—38. London, 1953.
Burnet, A. R. M. "Fishing by electricity". Canad. Fisherman, **40**, 8, p. 21. Montreal, 1953.
Dow, R. L., & Baird, F. T., Jr. "How to reduce lobster trap borer damage". Atlant. Fisherman, **34**, 10, pp. 16—7. Boston, 1953.
Fujita, H. "The drag acting on a net in a uniform current, (2)". Mem. Coll. Agric. Kyoto Univ., 66 (Fish. Ser. 3), pp. 11—20. Kyoto, 1953. (In Japanese).
Halås, M. "Fiskeforsøk med nylongarn sammenliknet med alminnelig torskegarn: Lofoten 1953". Fiskets Gang, 37, p. 446. Bergen, 1953.
Halmø, K. "Rapport om prøver foretatt med forskjellige typer av notflær". Fiskets Gang, 47, pp. 594—6. Bergen, 1953.
Huntsman, A. G. "Ausrichtung der Fische durch die Strömung und ihre Bedeutung für den Fang (von Meeresfischen)". Fischwirtsch., **5**, 6, pp. 144—6. Bremerhaven, 1953.
Kawasaki, G., Nishiyama, S., & Nakamura, H. "Studies on the fishery of the purse seines of the mackerel in the sea near Hokkaido. 1. The purse seines of the mackerel and a study of the composition". Bull. Faculty Fish., Hokkaido Univ., **3**, 4, pp. 277—80. Hakodate, 1953. (In Japanese, English summary).
Kawakami, T., & Tubota, H. "On the configuration and distribution of tension of a rope in a uniform stream". Mem. Coll. Agric. Kyoto Univ., 66, (Fish. Ser. 3), pp. 1—10. Kyoto, 1953. (In Japanese).
Kelley, D. W. "Fluctuation in trap net catches in the upper Mississippi River". U. S. Dept. Int., Fish Wildl. Serv., Spec. Sci. Rep. Fish., 101. Washington, 1953.
Khuong, N. L., & Serène, R. "Les procédés de pêche au thon des Viêtnamiens de Nhatrang". Bull. Soc. Études Indo-Chin., N. S., **27**, 1, pp. 5—13. Saigon, 1952.
Klust, G. "Eine Kastenreuse aus synthetischen Faserstoffen". Fischwirtsch., **5**, 10, pp. 240—1. Bremerhaven, 1953.
Kobayashi, K., & Nishizawa, S. "Studies on the fixed nets in Funka Bay. 2. On the automatic recording rope tensionmeter". Bull. Faculty Fish., Hokkaido Univ., **4**, 1, pp. 112—7. Hakodate, 1953. (In Japanese, English summary).
MacDuff, J. "Trap-net fishing at Fox Point, N. S.". Trade News, **6**, 3, pp. 3—4 & 16. Ottawa, 1953.
Lethlean, N. G. "An investigation into the design and performance of electric fish-screens and an electric fish-counter". Trans. Roy. Soc. Edinburgh, **62**, Pt. 2 (13), 1951—53. Edinburgh & London, 1953.
Massmann, W. H., Ladd, E. C., & McCutcheon, H. N. "A surface trawl for sampling young fishes in tidal rivers". Trans. 17th N. Amer. Wildl. Conf., 1952, pp. 386—92. Washington, 1952.
Murphy, G. I., & Shomura, R. S. "Longline fishing for deep swimming tunas in the central Pacific, 1950—51". U. S. Dept. Int., Fish Wildl. Serv., Spec. Sci. Rep. Fish., 98. Washington, 1953.
Niska, E. L. "Construction details of tuna long-line gear used by Pacific oceanic fishery investigations". Comm. Fish. Rev., **15**, 6, pp. 1—6. Washington, 1953.
Roger, E. "Les appâts employés pour la pêche de la sardine. — La rogue de morue". Rev. Trav. Off. Pêches Marit., **16**, 1—4, pp. 129—39. Paris, 1953.
Roséen, N. "Die schwedische Westküstenfischerei". Handb. Seefisch. Nordeuropas, **8**, 3a. Stuttgart, 1953.
Siebenaler, J. B. "Trap lift net for catching tuna bait fishes". Comm. Fish. Rev., **15**, 8, pp. 14—7. Washington, 1953.
Timmermann, G. "Die Altenwerder Fischerjolle, ein ausgestorbener Schiffstyp". Fischwirtsch., **5**, 10, pp. 245—6. Bremerhaven, 1953.
de la Tourrasse, G. "La pêche aux thons sur la côte Basque Française et son évolution récente". Rev. Trav. Off. Pêches Marit., **17**, 1. Paris, 1951.
van Tri, T., & Serène, R. "Étude descriptive d'un carrelet du Viêtnam". Bull. Soc. Études Indo-Chin., N. S., **27**, 1, pp. 25—32. Saigon, 1952.

Williams, F. R., & Hocking, A. W. "New craypot with welded mesh and how to make it". Fish. Newsletter, **12**, 9, pp. 12—3 & 17. Sydney, 1953.

7) d Fishing Grounds.

Anon. "Notice sur le chalutage Français en Indochine". Bull. Econom., Inst. Océanogr. Indochine, Contr. 1. Saigon.

Martin, W. R. "Identification of major groundfish stocks in Subarea 4 of the Northwest Atlantic Convention Area". Internat. Comm. N. W. Atlantic Fish., Ann. Proc., **3** (1952—53), pp. 57—61. Halifax, N. S., 1953.

Rokstad, G., & Amundsen, F. "Rapport om forsøksdriften med småtrålerne m/s 'Peder Rønnestad' og m/s 'Thor Iversen' fra April 1952 til April 1953". Fiskets Gang, 34, pp. 410—3. Bergen, 1953.

Wheeler, J. F. G., & Ommanney, F. D. "Report on the Mauritius—Seychelles fisheries survey 1948—1949". Colonial Off., Fish. Publ., **1**, 3. London, 1953.

8) Marine Fishery Investigations.

8) a Stocks and Effects of Fishing.

Dannevig, G. "Beskatningen av skreibestanden. Hva merkeforsøk i Lofoten viser. Foreløpig rapport". Fiskeridirek. Skr., Ser. Havunders., **10**, 8. Bergen, 1953.

Gordon, H. S. "An economic approach to the optimum utilization of fishery resources". Journ. Fish. Res. Board Canada, **10**, 7, pp. 442—57. Toronto, 1953.

Gulland, J. A. "Explanations of overfishing of demersal stocks". World Fishing, **2**, 7, pp. 268—72. London, 1953.

Gulland, J. A. "Vital statistics of fish populations". World Fishing, **2**, 8, pp. 316—9. London, 1953.

Hiyama, Y., Kusaka, T., & Nose, Y. "Individual differences and degree of difficulty in age determination of six fish species". Rec. Oceanogr. Work Japan, N. S., **1**, 1, pp. 138—48. Tokyo, 1953.

Hile, R., Lunger, G. F., & Buettner, H. J. "Fluctuations in the fisheries of State of Michigan waters of Green Bay". U. S. Dept. Int., Fish & Wildl. Serv., Fish. Bull. **54**, 75. Washington, 1953.

Ito, T. "On the statistical method of weight-length relationship in fish population". Bull. Japan. Soc. Sci. Fish., **19**, 8, pp. 905—11. Tokyo, 1953. (In Japanese, English summary).

Wood, E. M. "A century of American fish culture, 1853—1953". Prog. Fish-Culturist, **15**, 4, pp. 147—62. Washington, 1953.

8) b Cod.

Ancellin, J. "Summary report of the cruise of the French research vessel 'Président Théodore Tissier' in the region of Newfoundland and Labrador, Subareas 2 & 3, August—September, 1952". Internat. Comm. N. W. Atlantic Fish., Ann. Proc., **3** (1952—53), pp. 34—7. Halifax, N. S., 1953.

Anon. "Summary of research work by Norway in Subarea 1 in 1952". Internat. Comm. N. W. Atlantic Fish., Ann. Proc., **3** (1952—53), pp. 41—5. Halifax, N. S., 1953.

Dannevig, G. "Beskatningen av skreibestanden. Hva merkeforsøk i Lofoten viser. Foreløpig rapport". Fiskeridirek. Skr., Ser. Havunders., **10**, 8. Bergen, 1953.

Dannevig, G. "Hvor meget blir der fisket opp av Lofot-skreien?" Fiskets Gang, 48, pp. 606—10. Bergen, 1953.

Hansen, P. "The Danish researches in Subarea 1 in 1952". Internat. Comm. N. W. Atlantic Fish., Ann. Proc., **3** (1952—53), pp. 28—33. Halifax, N. S., 1953.

Jónsson, J. "Icelandic researches. Analysis of trawler caught cod in Greenland waters in 1952". Internat. Comm. N. W. Atlantic Fish., Ann. Proc., **3** (1952—53), pp. 38—40. Halifax, N. S., 1953.

Rasmussen, B. "Om fløytelinefisket i Holstensborgdjupet Vest-Grønland, 1953". Fiskets Gang, 13, pp. 160—6. Bergen, 1954.

Tåning, Å. V. "Long term changes in hydrography and fluctuations in fish stocks". Internat. Comm. N. W. Atlantic Fish., Ann. Proc., **3** (1952—53), pp. 69—77. Halifax, N. S., 1953.

Templeman, W. "Knowledge of divisions of stocks of cod, haddock, redfish and American plaice in Subareas 3 & 2 of the Northwest Atlantic Convention Area". Internat. Comm. N. W. Atlantic Fish., Ann. Proc., **3** (1952—53), pp. 62—6. Halifax, N. S., 1953.

Templeman, W. "Summary of Canadian groundfish research in the Convention Area during 1952". Internat. Comm. N. W. Atlantic Fish., Ann. Proc., **3**, (1952—53), pp. 25—7. Halifax, N. S., 1953.

8) c Haddock.

Graham, H. W. "United States research in Convention Area during 1952". Internat. Comm. N. W. Atlantic Fish., Ann. Proc., **3** (1952—53), pp. 49—51. Halifax, N. S., 1953.

Premetz, E. D. "Destruction of undersized haddock on Georges Bank, 1947—51". U. S. Dept. Int., Fish Wildl. Serv., Spec. Sci. Rep. Fish., 96. Washington, 1953.

Sætersdal, G. S. "The haddock in Norwegian waters. 1. Vertebrae counts and brood strength variations of young fish". Fiskeridirek. Skr., Ser. Havunders., **10**, 4. Bergen, 1952.

Sætersdal, G. S. "The haddock in Norwegian waters. 2. Methods in age and growth investigations". Fiskeridirek. Skr., Ser. Havunders., **10**, 9. Bergen, 1953.

Schuck, H. A. "Offshore grounds important to the United States haddock fishery". U. S. Dept. Int., Fish Wildl. Serv., Res. Rep., 32. Washington, 1952.

Templeman, W. "Knowledge of divisions of stocks of cod, haddock, redfish and American plaice in Subareas 3 & 2 of the Northwest Atlantic Convention Area". Internat. Comm. N. W. Atlantic Fish., Ann. Proc., **3** (1952—53), pp. 62—6. Halifax, N. S., 1953.

Templeman, W. "Summary of Canadian groundfish research in the Convention Area during 1952". Internat. Comm. N. W. Atlantic Fish., Ann. Proc., **3** (1952—53), pp. 25—7. Halifax, N. S., 1953.

8) d Hake.

Letaconnoux, R. "Gadidés—Merlu. Considérations sur l'exploitation du stock de merlu depuis 1937". Rev. Trav. Off. Pêches Marit., **16**, 1—4, pp. 72—89. Paris, 1951.

Matta, F. "Qualche considerazione sulla biologia del merluzzo (*Merluccius merluccius* L.) dei mari italiani. — Nota I". Boll. Pesca, Piscicolt. Idrobiol., **8**, 1, pp. 82—102. Roma, 1953.

8) f Plaice.

v. Ubisch, L. "Über die Zahl der Flossenstrahlen bei *Pleuronectes platessa*, *Pl. flesus* und der Bastarde und Rückkreuzungen zwischen beiden Arten". Zool. Anz., **151**, 5—6, pp. 75—86. Leipzig, 1953.

8) h Halibut.

Allen, E. W., Clark, G. R. *et al.* "Regulation and investigation of the Pacific halibut fishery in 1952". Rep. Internat. Fish. Comm., 20. Seattle, 1953.

van Cleve, R., & Seymour, A. H. "The production of halibut eggs on the Cape St. James spawning bank off the coast of British Columbia 1935—46". Rep. Internat. Fish. Comm., 19. Seattle, 1953.

Plessis, Y. "Application des phénomènes de capillarité a l'élevage de petits animaux marins". Bull. Mus. Nation. d'Hist. Natur., 2e Sér., **25**, 2, pp. 140—3. Paris, 1953.

8) i Other Pleuronectidae.

Hatanaka, M., & Iwahashi, S. "Studies on the populations of the flatfishes in Sendai Bay. 3. The biology of *Limanda yokohamae* (Günther)". Tohoku Journ. Agric. Res., **3**, 2, pp. 303—9. Sendai, 1953.

Ishida, R., & Kitakata, M. "Studies on the age determination of flat-fishes in Hokkaido. (3). *Glypto-cephalus stelleri* (Schmidt)". Bull. Hokkaido Region. Fish. Res. Lab., 8, pp. 63—84. Hokkaido, 1953. (In Japanese, English summary).

Rae, B. B. "The occurrence of lemon sole larvae in the Scottish plankton collections of 1929, 1930 and 1931". Scottish Home Dept., Mar. Res. 1953, 1. Edinburgh, 1953.

Yamamoto, K. "Studies on the maturity of marine fishes. 1. Seasonal cycle in the spermary of the flounder, *Liopsetta obscura*". Bull. Hokkaido Region. Fish. Res. Lab., 8, pp. 52—62. Hokkaido, 1953. (In Japanese, English summary).

8) j Herring.

Aasen, O. "The Østerbø herring". Fiskeridirekt. Skr., Ser. Havunders., **10**, 7. Bergen, 1953.

Ancellin, J. "Clupéidés — Hareng. Le hareng du sud de la Mer du Nord et de la Manche Orientale". Rev. Trav. Off. Pêches Marit., **16**, 1—4, pp. 19—38. Paris, 1951.
Blaxter, J. H. S. "Sperm storage and cross-fertilization of spring and autumn spawning herring". Nature, **172**, 4391, pp. 1189—90. London, 1953.
Bowers, A. B. "Studies on the herring (*Clupea harengus* L.) in Manx waters:— The autumn spawning, and the larval and post-larval stages". Proc. Trans. Liverpool Biol. Soc., **58**, pp. 47—74. Liverpool, 1952.
Bückmann, A., Harder, W., & Hempel, G. "Unsere Beobachtungen am Hering (*Clupea harengus* L.)". Kurze Mitt. Fischereibiol. Abt. Max-Planck-Inst. Meeresbiol., 3, pp. 22—42. Wilhelmshaven, 1953.
Bückmann, A., & Hempel, G. "Beobachtungen über Verteilung und Entwicklungszustand der Heringslarven an der west- und ostfriesischen Küste im Frühjahr 1952". Kurze Mitt. Fischereibiol. Abt. Max-Planck-Inst. Meeresbiol., 2, pp. 24—38. Wilhelmshaven, 1953.
Devold, F. "Småsildfiskets innflydelse på sildebestanden". Fiskets Gang, 46, pp. 575—80. Bergen, 1953.
Harder, W. "Zur postembryonalen Entwicklung des Darmes beim Hering (*Clupea harengus* L.)". Zeitschr. f. Anat. u. Entwicklungsgesch., **116**, pp. 379—98. Berlin, 1952.
Hempel, G. "Meristische Merkmale der Frühjahrsheringe in Ems und Elbe". Kurze Mitt. Fischereibiol. Abt. Max-Planck-Inst. Meeresbiol., 3, pp. 43—5. Wilhelmshaven, 1953.
Holm, A. "Vintersildfiskets lønnsomhet 1953". Fiskets Gang, 43, pp. 527—37. Bergen, 1953.
Hourston, A. S. "The relationship of herring in inshore waters to the temperature and salinity of their environment". Prog. Rep. Pacific Coast Stat., 96, p. 15. Vancouver, 1953.
Junker, M. "Die Vitamin A-Wirksamkeit von männlichen und weiblichen Heringsgonaden verschiedener Reifegrade". Arch. f. Fischereiwiss., 1952—53, pp. 19—35. Braunschweig, 1952.
Kondo, H., & Kitahama, H. "Marking experiment of the young herring (*Clupea pallasii*) in the Pacific coast of Hokkaido, 1949—52". Bull. Hokkaido Region. Fish. Res. Lab., 9, pp. 17—56. Hokkaido, 1953. (In Japanese, English summary).
Lühmann, M. "Über die Fettspeicherung bei Ostseeheringen und ihre Beziehung zum Fortpflanzungszyklus". Kieler Meeresforsch., **9**, 2, pp. 213—27. Kiel, 1953.
"Peko". "Herring behaviour: How depth limits change the shoaling pattern (1)". World Fishing, **2**, 7, pp. 276—81. London, 1953.
Yoshihara, T. "Fluctuations in the stock of Hokkaido spring herring. 1. Mean age composition". Bull. Japan. Soc. Sci. Fish., **19**, 7, pp. 828—31. Tokyo, 1953. (In Japanese, English summary).
Yoshihara, T. "Fluctuations in the stock of Hokkaido spring herring. 2. Net production rate". Bull. Japan. Soc. Sci. Fish., **19**, 7, pp. 832—35. Tokyo, 1953. (In Japanese, English summary).

8) k Sardine and other Clupeoids.

Ahlstrom, E. H. "Pilchard eggs and larvae and other fish larvae, Pacific coast 1951". U. S. Dept. Int., Fish Wildl. Serv., Spec. Sci. Rep. Fish., 102. Washington, 1953.
Andreu, B. "Some data on the fecundity of the sardine". Bol. Inst. Español Oceanogr., 4. Madrid, 1948.
Aurich, H. J. "Verbreitung und Laichverhältnisse von Sardelle und Sardine in der südöstlichen Nordsee und ihre Veränderungen als Folge der Klimaänderung". Helgoländer Wiss. Meeresunters., **4**, 3, pp. 175—204. List (Sylt), 1953.
Calderwood, M. M. "Length composition of Californian commercial catch of pilchard, 1919 to 1951". U. S. Dept. Int., Fish Wildl. Serv., Spec. Sci. Rep. Fish., 105. Washington, 1953.
Creac'h, P. V. "Sardine — Notes sur la biologie et la morphologie de la sardine (*Sardina pilchardus* Walb.) dans le fond du Golfe de Gascogne". Rev. Trav. Off. Pêches Marit., **16**, 1—4, pp. 44—71. Paris, 1951.
Felin, F. E., MacGregor, J., Daugherty, A. E., & Miller, D. J. "Age and length composition of the sardine catch off the Pacific coast of the United States and Mexico in 1952—53". Calif. Fish Game, **39**, 3, pp. 409—17. Sacramento, 1953.
le Gall, J. "L'aspect scientifique du problème sardinier". Pêche Marit., 905, pp. 337—40. Paris, 1953.
Muzinic, R. "Remarques sur le développement et la croissance des otolithes de la sardine (*Clupea pilchardus* Walb.)". Acta Adriatica, **4**, 13. Split, 1952.
Nair, R. V., & Chidambaram, K. "A review of the Indian oil sardine fishery". Proc. Nation. Inst. Sci. India, **17**, 1, pp. 71—85. Calcutta, 1951.

8)l Tunny and Mackerel.

Aikawa, H. "Notes on the shoal of Bonito (skipjack, *Katsuwonus pelamis*) along the Pacific coast of Japan". Bull. Japan. Soc. Sci. Fish., **6**, 1, pp. 13—21. Tokyo, 1937. (Translation. U. S. Dept. Int., Fish Wildl. Serv., Spec. Sci. Rep. Fish., 83, pp. 32—50. Washington, 1952.)

Anderson, A. W., Stolting, W. H., & Associates. "Survey of the domestic tuna industry". U. S. Dept. Int., Fish Wildl. Serv., Spec. Sci. Rep. Fish., 104. Washington, 1953.

Anon. "Inter-American Tropical Tuna Commission". Ann. Rep. 1952, pp. 3—61. La Jolla, California, 1953.

Aricò, F., & Genovese, S. "Sui caratteri biometrici del tonno (*Thunnus thynnus* L.) tirrenico". Boll. Pesca, Piscicolt. Idrobiol., **8**, 1, pp. 5—46. Roma, 1953.

Bini, G. "La campagna esplorativa per la pesca vagantiva del tonno, compiuta nel Golfo di Napoli nel Luglio 1952". Boll. Pesca, Piscicolt. Idrobiol., **8**, 3, pp. 1—4. Roma. 1953.

Fitch, J. E. "Age composition of the Southern California catch of Pacific mackerel for the 1952—53 season". Calif. Fish Game, **39**, 4, p. 553. Sacramento, 1953.

Ganssle, D., & Clemens, H. B. "California-tagged albacore recovered off Japan". Calif. Fish Game, **39**, 4, p. 443. Sacramento, 1953.

Ikehara, I. I. "Live-bait fishing for tuna in the central Pacific". U. S. Dept. Int., Fish Wildl. Serv., Spec. Sci. Rep. Fish., 107. Washington, 1953.

Letaconnoux, R. "Considérations nouvelles sur les migrations du germon". Rev. Trav. Off. Pêches Marit., **16**, 1—4, pp. 39—43. Paris, 1951.

Meyer, A. "Wertvolle Thunfischleber". Fischereiwelt, **4**, 7, p. 102. Bremerhaven, 1952.

Morice, J. "La pêche des thons à Cuba". Pêche Marit., 907, pp. 438—42. Paris, 1953.

Murphy, G. I., & Shomura, R. S. "Longline fishing for deep swimming tunas in the central Pacific, 1950—51". U. S. Dept. Int., Fish Wildl. Serv., Spec. Sci. Rep. Fish., 98. Washington, 1953.

Sasaki, T. "Skipjack fishing grounds and oceanographic conditions in the northeastern sea area". Miyagi Prefect. Fish. Exper. Stat., Fish. Guidance Material, 1, 1939. (Translation. U. S. Dept. Int., Fish Wildl. Serv., Spec. Sci. Rep. Fish., 83, pp. 1—21. Washington, 1952.)

Tauchi, M. "On the stock of skipjack". Bull. Japan. Soc. Sci. Fish., **11**, 5—6, pp. 179—83. Tokyo, 1943. (Translation. U. S. Dept. Int., Fish Wildl. Serv., Spec. Sci. Rep. Fish., 83, pp. 22—31. Washington, 1952.)

de la Tourrasse, G. "La pêche aux thons sur la côte Basque Française et son évolution récente". Rev. Trav. Off. Pêches Marit., **17**, 1. Paris, 1951.

Uda, M., & Tsukushi, J. "Local variations in the composition of skipjack (*Katsuwonus pelamis*) schools". Bull. Japan. Soc. Sci. Fish., **3**, 4, pp. 196—202. Tokyo, 1934. (Translation. U. S. Dept. Int., Fish Wildl. Serv., Spec. Sci. Rep. Fish., 83, pp. 51—67. Washington, 1952.)

Uda, M. "Types of skipjack schools and their fishing qualities". Bull. Japan. Soc. Sci. Fish., **2**, 3, pp. 107—11. Tokyo, 1933. (Translation. U. S. Dept. Int., Fish Wildl. Serv., Spec. Sci. Rep. Fish., 83, pp. 68—78. Washington, 1952.)

Venkataraman, R., & Sreenivasan, A. "Preliminary investigation of the bacterial flora of the mackerels of the west coast". Indian Journ. Med. Res., **40**, 4, pp. 529—33. Calcutta, 1952.

Wilson, R. C. "Tuna marking, a progress report". Calif. Fish Game, **39**, 4, pp. 429—42. Sacramento, 1953.

8)m Other Commercial Species.

Abe, T., & Ichkawa, Z. "Preliminary report on the tagging experiments of the 'Hokke', *Pleurogrammus azonus* Jordan et Metz, carried out in Japan Sea off the coasts of Noto peninsula". Bull. Tokai Region. Fish. Res. Lab., **6**, 67. Tokyo, 1953. (In Japanese, English summary).

Anon. "Beretning om selfangsten, håkjerringfisket og overvintringsekspedisjonene i 1952". Årsber. vedk. Norges Fisk., 1952, 9. Bergen, 1953.

Chenard, M., Desbrosses, P., & le Gall, J. "Squales — Le pélerin (*Cetorhinus maximus* Gunner) et sa pêche". Rev. Trav. Office Pêches Marit., **16**, 1—4, pp. 90—109. Paris, 1951.

Graham, H. W. "United States research in Convention Area during 1952". Internat. Comm. N. W. Atlantic Fish., Ann. Proc., **3** (1952—53), pp. 49—51. Halifax, N. S., 1953.

Hempel, G. "Meristische Merkmale von Hornhechten (*Belone acus* Risso) aus dem Jadebusen und dem Golf von Neapel". Kurze Mitt. Fischereibiol. Abt. Max-Planck-Inst. Meeresbiol., 2, pp. 20—3. Wilhelmshaven, 1953.

Kambara, H., Tanino, Tsujisaki, H., Takasugi, S., & Ono, K. "Studies on the hokke (*Pleurogrammus azonus* Jordan et Metz). 1. The spawning season and the multiplicity of spawning". Bull. Hokkaido Region. Fish. Res. Lab., 9, pp. 57—66. Hokkaido, 1953. (In Japanese, English summary).

Planas, A., & Vives, F. "Contribución al estudio del jurel (*Trachurus trachurus* L.) del Mediterraneo occidental. (Sectores de Vinaroz e islas Columbretes)". Publ. Inst. Biol. Aplicada, **13**, pp. 155—86. Barcelona, 1953.

Templeman, W. "Knowledge of divisions of stocks of cod, haddock, redfish and American plaice in Subareas 3 & 2 of the Northwest Atlantic Convention Area". Internat. Comm. N. W. Atlantic Fish., Ann. Proc., **3** (1952—53), pp. 62 -6. Halifax, N. S., 1953.

Tester, A. L., & Takata, M. "Contribution to the biology of the aholehole a potential baitfish". Indust. Res. Advis. Counc. Grant 29, Final Rep., Contrib. 38, Hawaii Mar. Lab. Hawaii, 1953.

Wirszubski, A. "On the biology and biotope of the red mullet *Mullus barbatus* L.". State Israel Min. Agric., Dept. Fish., Sea Fish. Res. Stat., Bull. 7, pp. 3—20. Caesarea, 1953.

8)n Hatcheries and Aquaria.

Dempster, R. P. "The use of larval and adult brine shrimp in aquarium fish culture". Calif. Fish Game, **39**, 3, pp. 355—64. Sacramento, 1953.

Gillbricht, M. "Die Belüftung von Seewasseraquarien". Kurze Mitt. Fischereibiol. Abt. Max-Planck-Inst. Meeresbiol., 3, pp. 1—21. Wilhelmshaven, 1953.

Judges, E. C., & Southward, A. J. "A note on the populations in the sea-water storage tanks". Ann. Rep. 1952 (65) Mar. Biol. Stat. Port Erin, Isle of Man, pp. 24—7. Liverpool, 1953.

Meehean, O. L., Douglass, E. J., & Duncan, L. M. "Propagation and distribution of food fishes for the calendar years 1944—48". U. S. Dept. Int., Fish Wildl. Serv., Statist. Digest, 24. Washington, 1952.

Wolf, H. "Colored fish-food pellets". Prog. Fish-Culturist, **15**, 4, p. 182. Washington, 1953.

8)o Whales and Seals.

Anon. "Beretning om selfangsten, håkjerringfisket og overvintringsekspedisjonene i 1952". Årsber. vedk. Norges Fisk., 1952, 9. Bergen, 1953.

Anon. "Report on whale marking in Japan. No. 4. Bonin Islands, Sanriku-Hokkaido and South Kurile Islands areas 1952". Tokyo, 1953. (In Japanese).

Chittleborough, R. G. "Studies on the ovaries of the humpback whale, *Megaptera nodosa* (Bonnaterre), on the western Australian coast". Austral. Journ. Mar. Freshw. Res., **5**, 1, pp. 35—63. Melbourne, 1954.

Gibbney, L. "Delayed implantation in the elephant seal". Nature, **172**, 4378, pp. 590—1. London, 1953.

Hayes, W. D. "Wave riding of dolphins". Nature, **172**, 4388, p. 1060. London, 1953.

Mackintosh, N. A. "A whale-marking expedition". Nature, **172**, 4386, pp. 933—4. London, 1953.

Pike, G. C. "Two records of *Berardius bairdi* from the coast of British Columbia". Journ. Mammal., **34**, 1, pp. 98—104. Baltimore, 1953.

Rankin, J. J. "First record of the rare beaked whale, *Mesoploden europaeus* Gervais, from the West Indies". Nature, **172**, 4384, pp. 873—4. London, 1953.

Ruud, J. T., Clarke, R., & Jonsgård, A. "Whale marking trials at Steinshamn, Norway". Norw. Whaling Gaz., 8, pp. 429—41. Oslo, 1953.

Sakiura, H., Nozawa, Y., & Ozaki, K. "Study on maturity and blubber thickness of the whales caught in the adjacent waters of Japan". Fish. Agency Japan. Govt. Tokyo, 1953.

Sakiura, H., Ozaki, K., & Fujino, K. "Biological investigations of the Northern Pacific baleen whales caught by the Japanese whaling fleet in 1952". Fish. Agency Japan Govt. Tokyo, 1953.

Schevill, W. E., & Lawrence, B. "Auditory response of a bottlenosed porpoise, *Tursiops truncatus*, to frequencies above 100 KC". Journ. Exper. Zool., **124**, 1, pp. 147—65. Philadelphia, 1953.

9) Freshwater Fisheries and Fishery Investigations.

9) a Salmonidae.

Anon. "Use of sodium amytal on fish in California". Prog. Fish-Culturist, **15**, 4, pp. 190—1. Washington, 1953.

Anon. "Fifth annual report of the Supervisory Committee for Brown Trout Research 1952—53". Freshwater Salmon Fish. Res., Scottish Home Dept., 6, pp. 3—12. Edinburgh, 1954.

Anon. "How far and fast can salmon travel?". Salmon Trout Mag., **135**, pp. 146—53. London, 1952.

Birman, I. B. "On the numbers of migrating salmon in relation to the stage of their freshwater life and the passage of the migratory phase of the lives of these fishes". Zool. Zhurn., **32**, 5, pp. 923—31. Moscow, 1953. (In Russian).

Cervero, L. G. "La pesca del salmonete en Valencia". Industr. Pesqueras, **27**, 625—6. pp. 56—7. Vigo, 1953.

Cooper, E. L. "Mortality rates of brook trout and brown trout in the Pigeon River, Otsego County, Michigan". Prog. Fish-Culturist, **15**, 4, pp. 163—9. Washington, 1953.

Cope, O. B. "Length measurements of Lake Yellowstone trout". U. S. Dept. Int., Fish Wildl. Serv., Spec. Sci. Rep. Fish., 103. Washington, 1953.

Fry, F. E. J. "The 1944 year-class of lake trout in South Bay, Lake Huron". Trans. American Fish. Soc., **82**, pp. 178—92. New York, 1952.

Fry, F. E. J., & Gibson, M. B. "Lethal temperature experiments with speckled trout × lake trout hybrids". Journ. Heredity, **44**, 2. Washington, 1953.

Fulton, L. A., & Gangmark, H. A. "Trial of dentil-type fish ladder on Pacific salmon". U. S. Dept. Int., Fish Wildl. Serv., Spec. Sci. Rep. Fish., 99. Washington, 1953.

Haworth-Booth, R. "Salmon mortality on the ebb tide". Salmon Trout Mag., **135**, pp. 154—7. London, 1952.

Huntsman, H. G. "Wandering versus homing in salmon". Salmon Trout Mag., **136**, pp. 185—91. London, 1953.

Johnson, H. E., & Brice, R. F. "Effects of transportation of green eggs, and of water temperature during incubation, on the mortality of chinook salmon". Prog. Fish-Culturist, **15**, 3, pp. 104—8. Washington, 1953.

Johnson, R. S. "Early and late running salmon". Salmon Trout Mag., **138**, pp. 135—40. London, 1953.

Maéda, H. "Ecological analyses of pelagic shoals. 1. Analysis of salmon gill-net association in Aleutian. (2) Distribution of fishes on the gill-net". Bull. Japan. Soc. Sci. Fish., **19**, 4, pp. 305—18. Tokyo, 1953.

Neave, F. "'Even-year' and 'odd-year' pink salmon populations". Trans Roy. Soc. Canada, **46**, Ser. 3, pp. 55—70. Ottawa, 1952.

Neave, F., Hunter, J. G., & Wickett, W. P. "The 1952—54 pink salmon cycle in the Queen Charlotte Islands". Prog. Rep. Pacific Coast Stat., 96, pp. 22—4. Vancouver, 1953.

Nielson, R. S. "Should we stock brown trout?". Prog. Fish-Culturist, **15**, 3, pp. 125—6. Washington, 1953.

Nursall, J. R., & Hasler, A. D. "A note on experiments designed to test the viability of gametes and the fertilization of eggs by minute quantities of sperm". Prog. Fish-Culturist, **14**, 4, pp. 165—8. Washington, 1952.

Powers, E. B. "Chemical factors affecting the migratory movements of the Pacific salmon". Migr. Conserv. Salmon, pp. 72—85. Lancaster, Pa., 1939.

Pritchard, A. L., & Delacy, A. C. "Pink salmon tagging experiments during 1943 in southern British Columbia and the Puget Sound area of the State of Washington". Prog. Rep. Pacific Coast Stat., 58, pp. 8—12. Vancouver, B. C., 1944.

Royal, L. A. "The effects of regulatory selectivity on the productivity of Fraser River sockeye". Canad. Fish Culturist, 14, pp. 1—12. Ottawa, 1953.

Rucker, R. R., Whipple, W. J., Parvin, J. R., & Evans, C. A. "A contagious disease of salmon possibly of virus origin". U. S. Dept. Int., Fish Wildl. Serv., Fish. Bull., **54**, 76. Washington, 1953.

Seymour, A. H., & Donaldson, J. R. "Occurrence of high mortality among chinook salmon fry after the recharge of a charcoal filter". Prog. Fish-Culturist, **15**, 3, pp. 129—30. Washington, 1953.

Stewart, R. N. "Icelandic char". Salmon Trout Mag., **133**, pp. 239—44. London, 1951.

Went, A. E. J. "Notes on Irish sea-trout". Salmon Trout Mag., **134**, pp. 39—47. London, 1952.

Willoughby, H. "Use of pellets as trout food". Prog. Fish-Cuturist, **15**, 3, pp. 127—8, Washington, 1953.
Wolf, P. "American problems and practice. 5. Natural spawning or artificial production?". Salmon Trout Mag., **134**, pp. 9—15. London, 1953.
Wolf, H., & Wales, J. H. "Color perception in trout". Copeia, 4, pp. 234—6. Baltimore, 1953.
Wolfe, L. E. "Experiments with antibiotics and vitamin B12 in the diets of brown trout fingerlings". Prog. Fish-Culturist, **14**, 4, pp. 148—53. Washington, 1952.

9) b Eels.

Carlsen, H. "Der Cocarboxylasegehalt des Aales (*Anguilla vulgaris* L.)". Zeitschr. vergleich. Physiol., **35**, 3, pp. 199—28. Berlin, 1953.
Halås, M. "Fangst og behandling av nedgangsål (blankål)". Fiskeridirek. Skr., Ser. Fiskeri, **3**, 1. Bergen, 1953.
Jens, G. "Über den lunaren Rhythmus der Blankaalwanderung". Arch. f. Fischereiwiss., 1952—53, pp. 94—110. Braunschweig, 1953.
Meyer, P. F., & Kühl, H. "Welche Milieu-Faktoren spielen beim Glasaalaufstieg eine Rolle?". Arch. f. Fischereiwiss., 1952—53, pp. 87—94. Braunschweig, 1953.
Schäperclaus, W. "Die Blumenkohlkrankheit der Aale und anderer Fische der Ostsee". Zeitschr. Fisch. u. d. Hilfswiss., **2**, N. F., 1—2, pp. 105—24. Radebeul & Berlin, 1953.
Wundsch, H. H. "Das Vorkommen von Aalen in 'vorgeschrittenem Reifezustand' in einem märkischen Binnengewässer". Zeitschr. Fisch. u. d. Hilfswiss., **2**, N. F., 1—2, pp. 1—18. Radebeul & Berlin, 1953.

9) c Other Commercial Species.

Hamada, K. "Ecological study of the pond smelt, *Hypomesus olidus* (Pallas). Report 3. Uncertainty of age determination by the scale structure on the pond smelt obtained from Lake Abashiri, and the reasons therefore". Bull. Faculty Fish., Hokkaido Univ., **4**, 1, pp. 46—53. Hakodate, 1953. (In Japanese).
Kennedy, W. A. "Growth, maturity, fecundity and mortality in the relatively unexploited whitefish, *Coregonus clupeaformis*, of Great Slave Lake". Journ. Fish. Res. Board Canada, **10**, 7, pp. 413—41. Toronto, 1953.
Loeb, H. A. "Sea lamprey spawning: Wisconsin and Minnesota streams of Lake Superior". U. S. Dept. Int., Fish Wildl. Serv., Spec. Sci. Rep. Fish., 97. Washington, 1953.
Sears, N. J. "Methods and techniques used in trap-cropping largemouth black bass from Lake Mills, Wisconsin, hatchery ponds". Prog. Fish-Culturist, **15**, 3, pp. 121—2. Washington, 1953.
Sommani, E. "Esperimenti di allevamento artificiale del temolo (*Thymallus thymallus*)". Boll. Pesca, Piscicolt. Idrobiol., **8**, 1, pp. 47—57. Roma, 1953.
van Someren, V. D. "New fish culture methods for *Tilapia* in East Africa". Nature, **172**, 4373, pp. 330—32. London, 1953.
Wunder, W. "Ergebnisse eines Leistungsprüfungsversuches, der im Jahr 1951 im Aischgrund durchgeführt wurde, mit Karpfenstämmen aus Schwaben, aus der Oberpfalz und aus dem Aischgrund". Arch. f. Hydrobiol., **48**, 1, pp. 105—20. Stuttgart, 1953.

9) d Effects of Pollution.

Nitta, T., Arakawa, K., Sugimoto, H., & Fujiya, M. "Study on pollution by industrial sewage". Bull. Nakai Region. Fish. Res. Lab., 3. Ujina Hiroshima, 1953. (In Japanese, English summary).
Pentelow, F. T. K. "River purification. A legal and scientific review of the last 100 years, being the Buckland Lectures for 1952". Edward Arnold, London, 1953.

9) e Ecology.

Hile, R., Lunger, G. F., & Beuttner, H. J. "Fluctuations in the fisheries of State of Michigan waters of Green Bay". U. S. Dept. Int., Fish Wildl. Serv., Fish. Bull., **54**, 75. Washington, 1953.

10) Shellfisheries.

10) a Molluscs.

Anon. "Poste station d'épuration des huîtres du Tage". Bol. da Pesca, **10**, 39. Lisboa, 1953.

Asano, M., Takayanagi, F., & Kitamura, T. "Shellfish poisoning from *Callista brevisiphonata* Carpenter and its clinical symptoms". Tohoku Journ. Agric. Res., **3**, 2, pp. 321—30. Sendai, 1953. (In Japanese).

Baggerman, B. "Spatfall and transport of *Cardium edule* L.". Arch. Néerland. Zool., **10**, 3, pp. 315—42. Haarlem, 1953.

Buddenbrock, W. V., & Moller-Racke, I. Über den Lichtsinn von *Pecten*". Pubbl. Staz. Zool. Napoli, **24**, 2, pp. 217—45. Napoli, 1953.

Butler, P. A. "Effect of floodwaters on oysters in Mississippi Sound in 1950". U. S. Dept. Int., Fish Wildl. Serv., Res. Rep., 31. Washington, 1952.

Butler, P. A. "Oyster growth as affected by latitudinal temperature gradients". Comm. Fish. Rev., **15**, 6, pp. 7—12. Washington, 1953.

Furukawa, A., & Suzuki, M. "Biological study on shallow water production. I. On the spatial distribution of *Meretrix lusoria* and *Mactra veneriformis* in a certain natural clam seed bed". Bull. Japan. Soc. Sci. Fish., **18**, 12, pp. 723—6. Tokyo, 1953. (In Japanese, English summary).

Glude, J. B., & Landers, W. S. "Biological effects on hard clams of hand raking and power dredging". U. S. Dept. Int., Fish Wildl. Serv., Spec. Sci. Rep. Fish., 110. Washington, 1953.

Gunter, G. "The relationship of the Bonnet Carre Spillway to oyster beds in Mississippi Sound and the 'Louisiana Marsh', with a report on the 1950 opening". Publ. Inst. Mar. Sci., **3**, 1, pp. 17—71. Port Aransas, Texas, 1953.

Heldt, H. "Observations sur la ponte chez la moule (*Mytilus galloprovincialis* Lmk.) et l'émission des produits sexuels mâles chez la palourde (*Tapes decussatus* Forbes et Hanley)". Bull. Soc. Sci. Nat. Tunisie, **5**, 1—4, pp. 171—4. Tunis, 1952.

Hepper, B. T. "Artificial infection of various molluscs with *Mytilicola intestinalis*, Steuer". Nature, **172**, 4371, p. 250. London, 1953.

Ingle, R. M. "Studies on the effect of dredging operations upon fish and shellfish". Div. Oyster Cult., Board Conserv., Techn. Ser., 5. Tallahassee, Fla., 1952.

Ingle, R. M., & Walton Smith, F. G. "Oyster culture in Florida". State Florida Bd. Conserv., Div. Oyster Cult., Univ. Miami Mar. Lab., Educ. Ser., 5. Coral Gables, 1953.

Kotake, N. "Experimental studies on the propagation of the pearl oyster, *Pinctada martensi*. 1. Seasonal appearance of planctonic larvae stage". Bull. Japan. Soc. Sci. Fish., **19**, 3, pp. 145—50. Tokyo, 1953. (In Japanese, English summary).

Krvaric, M. "Investigation into the nutritive value of Adriatic oyster (*Ostrea edulis* Linné)". Acta Adriatica, **5**, 4. Split, 1953.

Kühl, H. "Studien über die Klaffmuschel *Mya arenaria*. Die Myasiedlungen am Hakensand (Elbmündung)". Arch. f. Fischereiwiss., 1952—53, pp. 126—32. Braunschweig, 1953.

Lambert, L. "Ostréiculture, Mytiliculture, Conchyliculture. L'ostréiculture et la mytiliculture en Zélande (Pays-Bas)". Rev. Trav. Off. Pêches Marit., **16**, 1—4, pp. 111—28. Paris, 1951.

Ogasawara, Y., & Furukawa, A. "Fundamental studies of technique in oyster culture. (1). On size and some observations of the larvae setted". Bull. Naikai Region. Fish. Res. Lab., 5, pp. 21—4. Ujina Hiroshima, 1953. (In Japanese, English summary).

Olsen, A. M. "Diving investigations on scallop beds". Fish. Newsletter, **12**, 7, pp. 5—7. Sydney, 1953.

Thomson, J. M. "The genera of oysters and the Australian species". Austral. Journ. Mar. Freshw. Res., **5**, 1, pp. 132—68. Melbourne, 1954.

Yoshida, H. "Studies on larvae and young shells of industrial bivalves in Japan". Journ. Shimonoseki College Fish., **3**, 1, Shimonoseki City, 1953. (In Japanese, English summary).

10) b Crustacea.

Heegaard, P. E. "Observations on spawning and larval history of the shrimp, *Penaeus setiferus* (L.)". Publ. Inst. Mar. Sci., **3**, 1, pp. 73—105. Port Aransas, Texas, 1953.

Meredith, S. S. "A study of *Crangon vulgaris* in the Liverpool Bay area". Proc. Trans. Liverpool Biol. Soc., **58**, pp. 75—109. Liverpool, 1952.

Wilder, D. G. "The growth rate of the American lobster (*Homarus americanus*)". Journ. Fish. Res. Board Canada, **10**, 7, pp. 371—412. Toronto, 1953.

Sutcliffe, W. H. "Further observations on the breeding and migration of the Bermuda spiny lobster, *Panulirus argus*". Journ. Mar. Res., **12**, 2, pp. 173—83. New Haven, Conn., 1953.
Thomas, H. J. "Some observations on the distribution, biology and exploitation of the Norway lobster". Scottish Home Dept., Mar. Res., 1. Edinburgh, 1954.
Yasuda, J., Takamori, S., & Nishina, S. "Study on the ecology of Akiami (*Acetes japonicus* Kishinouye) and its multiplication and protection". Bull. Nakai Region. Fish. Res. Lab., 4, pp. 1—19. Ujina Hiroshima, 1953. (In Japanese, English summary).

11) Miscellaneous.

11) a General.

Anon. "Die Weltmeere Taschenatlas". Geogr.-Kartogr. Anstalt. Gotha, 1954.
Anon. "La Mer". Librairie Larousse. Paris, 1953.
Anon. "Oil pollution of the sea". Nature, **172**, 4388, pp. 1025—6. London, 1953.
Anon. "Report of the committee on the prevention of pollution of the sea by oil". H. M. S. O., London, 1953.
Barnes, H. "Underwater television and research in marine biology, bottom topography and geology. Part 1. A description of the equipment and its use on board ship". Deutsch. Hydrogr. Inst., **6**, 3, pp. 123—33. Hamburg, 1953.
Besnard, W. "Un nouveau dispositif pour mensuration dans les travaux biométriques Bol. Inst. Oceanogr., **3**, 1—2, pp. 125—30. São Paulo, 1952.
Bonham, K., & Bayliff, W. H. "Radiography of small fishes for meristic studies". Copeia, 3, pp. 150—1. Baltimore, 1953.
Butler, R. L., & Smith, L. L. "A method for cellulose acetate impressions of fish scales with a measurement of its reliability". Prog. Fish-Culturist, **15**, 4, pp. 175—8. Washington, 1953.
Campbell, R. S., & Witt, A. "Impressions of fish scales in plastic". Journ. Wildl. Management, **17**, 2, pp. 218—9. Ithaca, N. Y., 1953.
Chapin, H., & Walton Smith, F. G. "The Ocean River". Victor Gollancz. London, 1953.
Jackson, P. A. "A simple type of fish counter". Salmon Trout Mag., **138**, pp. 170—1. London, 1953.
King, W. "The first year of federal aid in fish restoration". Prog. Fish-Culturist, **14**, 4, pp. 135—47. Washington, 1952.
Monstad, M. "Fiskerilitteratur 1951. Med tilføyelser for tidligere år". Årsber. vedk. Norges Fisk., 1951, 3. Bergen, 1953.
Schnakenbeck, W. "Die deutsche Seefischerei in Nordsee und Nordmeer". Krögers Buchdruck., Hamburg-Blankenese, 1953.
Simpson, F. A. (Edit.) "The Antarctic today". Phoenix House. London, 1952.
Stephen, A. C. "Scottish turtle records previous to 1953". Scottish Naturalist, **65**, 2, pp. 108—14. Aberdeen, 1953.
White, H. C. "The eastern belted kingfisher in the maritime provinces". Fish. Res. Board Canada, Bull., 97. Toronto, 1953.
Willgohs, J. F. "Common loggerhead *Caretta caretta* (Linné) stranded in western Norway with some remarks on its specific diagnosis". Univ. Bergen Årbok 1952, Naturvit. rekke, 17. Bergen, 1952.
Wiseman, J. D. H. "International collaboration in deep-sea research". Deep-Sea Res., **2**, pp. 3—10. London, 1953.
Yonge, C. M. "The influence of man on marine life". Endeavour, **6**, 21. London, 1947.
Young, P. H., Schott, J. W., & Collyer, R. D. "The use of monofilament nylon for attaching Petersen disk fish tags". Calif. Fish Game, **39**, 4, pp. 445—62. Sacramento, 1953.
Zobairi, A. R. K. "A report on the fisheries of East Bengal, Pakistan". Prog. Fish-Cuturist, **15**, 3, pp. 116—20. Washington, 1953.

11) b Mathematical and Statistical Methods.

Andrewartha, H. G., & Birch, L. C. "The Lotka-Volterra theory of interspecific competition". Austral. Journ. Zool., **1**, 2, pp. 174—77. Melbourne, 1953.
Barnes, H. "A note on cumulative frequency curves". Mem. Ist. Italiano Idrobiol., 7 pp. 201—7. Pallanza, 1953.
Finney, D. J. "Statistical method in biological assay". Charles Griffen. London, 1952.
Hammersley, J. M. "Capture-recapture analysis". Biometrika, **40**, 3—4, pp. 265—78. London, 1953.

Hiyama, Y., Kusaka, T., & Nose, Y. "Individual differences and degree of difficulty in age determination of six fish species". Rec. Oceanogr. Works Japan, N. S., **1**, 1, pp. 138—48. Tokyo, 1953.

Ricker, W. E. "Numerical relations between abundance of predators and survival of prey". Canadian Fish Culturist, 13, pp. 1—5. Ottawa, 1952.

Shewan, J. M., MacIntosh, R. G., Tucker, C. G., & Ehrenberg, A. S. C. "The development of a numerical scoring system for the sensory assessment of the spoilage of wet white fish stored in ice". Journ. Sci. Food & Agric., 6, pp. 283—98. London, 1953.